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The Cornell engineer

OCTOBER, 1951

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25 CENTS

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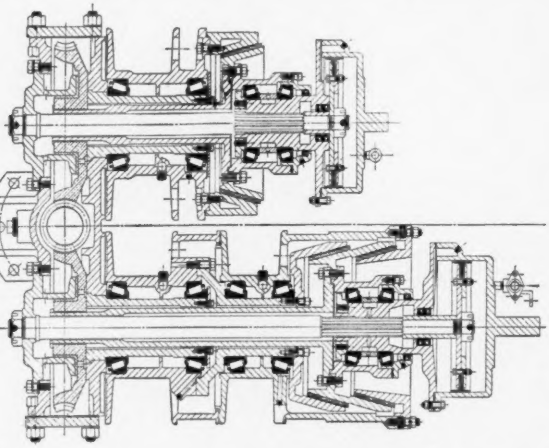

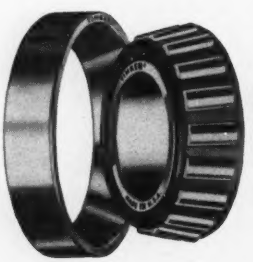

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"What a way for a guy to wake up!

"Maybe we shouldn't've listened to that horror program on the radio, where secret police dragged a family off to a concentration camp.

"Anyway, when that pounding on the door woke up Ethel and me...brother, I was practically on my way to some Siberian salt mine.

"Sure, I finally opened the door... and there stood McCarthy, the night cop on our beat. It was only a short-circuit fire in our kitchen.

"*Only* a fire? Wow! But with his help we put it out before any damage was done. Then Ethel made hot coffee and we finally got back to bed.

"Only I couldn't get back to sleep for a couple of hours. Kept thinking suppose it *was* the secret police! But that was nonsense. Here in America the police *help* us . . . not *hound* us like they do in countries where folks have forgotten what the word 'Freedom' means.

"Ah-h-h . . . Freedom! Pick your own church, your own newspaper, your own candidates. Pay your taxes but do what you want with the rest. Own a house or rent it. Drive your own car or take a bus. Loaf or pick out a good job like I have with Republic. Help produce steel or autos or tanks . . . or work in a store or a bank, as you please.

"Guess I'd gotten maybe a little too used to these Freedoms to appreciate them. So I made myself some promises. One was to read further than the sports pages. Another was to keep my eyes and ears peeled for those characters who try to do us out of our Freedoms.

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INTERIOR BALLISTICS

The Theory of Firearms

By GEORGE W. SUTTON, ME '52

Most engineers and scientists like to believe that high speed and high acceleration machinery are a product of modern engineering methods and the more recently discovered laws of motion. But powder guns and cannons were doing their nefarious business long before the celebrated apple inspired the thinking of Sir Isaac Newton. When contrasted against some modern devices, the operation of a gun is infinitely more complex. For instance, the average air compressor can deliver air at only 200 psi; bottled air is at about 2000 psi; but the pressures built up within the chamber of a cannon often exceed 40,000 psi! In terms of accelerations, an expensive automobile can accelerate to 60 mph in 10 seconds; but a projectile achieves a velocity of 2,000 feet per second in only 0.03 seconds!

The history of guns has been long, and unfortunately, rather bloody. Prehistoric man is supposed to have discovered incendiary compounds in the form of impure potassium nitrate and charcoal, which he used to tinder his fires; and shortly after the fall of the Roman Empire, the Chinese were busy making fireworks. But it was not until the early fourteenth century that Roger Bacon, after crystallizing pure potassium nitrate, caused the first explosion by adding sulphur and charcoal to it, calling the mixture gunpowder. When Berthold Schwartz evolved the theory of the gun in the early fourteenth century, he concluded that this gunpowder would be the best propellant. The invention spread with the speed of cannon balls; an Oxford manuscript showed a picture of a gun in 1325; the following year cannons were being manufactured in Florence; and in 1331, the Germans were busy annilhilating the Italians. At first cannon were popular only for siege work, taking the place of slower and more cumbersome machines of war. A prince had only to borrow a few pieces, and he had soon blown to bits his feudal lord's castle. As iron-working methods were improved, the breech block was added, as was rifling of the bore; and in the seventeenth century, the granular form of powder replaced the pulverized form.

Stresses in anything from human bones to the breechblocks on big guns are analyzed by means of a new "photoplastic" being demonstrated here.

—*Courtesy Westinghouse Corporation*

Scientific Approach

The first scientific approach to ballistics was made by Benjamin Robbins in England in 1743, when he introduced the ballistic pendulum. Although nitroglycerine was developed in 1845, it was not until 1886 that the Frenchman Vieille used it as a propellant. Progressive burning was suggested by Rodman in the United States in 1860, by using a perforated grain. Since that time, numerous researchers have made it possible to predict performance within an amazing degree of accuracy.

The general interior ballistic problem is stated very simply: given the composition, shape, and weight of powder, the chamber volume, and the projectile weight, find the projectile velocity and chamber pressure as a function of time, until the projectile leaves the muzzle of the gun. What happens to the projectile after it leaves the muzzle is dealt with by the science of exterior ballistics.

To start off the analysis, a better understanding can be obtained by comparing the gun, which is actually an internal engine, with a gasoline engine. In the gasoline engine, combustion is initiated by a localized elevation of temperature at the spark plug; combustion is usually started in a gun by a smaller charge, called the primer or initiator; however, the fuel of the spark ignition engine is gaseous, but in the gun it is solid. In both the gun and the engine, detonation (a sudden rise of pressure) is undesired; rather, smooth burning is sought. Sealing of the chamber is accomplished in the engine with piston rings; the projectile has a copper driving band in its base which is plastically deformed during firing to fit the gun bore. The source of oxygen in the engine is air; but in propellants it is usually in chemical combination in a nitrogen radical. But the most important difference is that the piston motion of the engine is controlled by the crank angle and is essentially cycloidal; but in the gun the projectile motion is free.

Slow Powders Used

As mentioned before, the types of powders used to accelerate the projectile are called propellants. Their rate of burning is slower than that of high explosives, which detonate immediately, detonation being unsuitable for closed chamber burning. The propellant powder is usually nitrocellulose alone or in combination with nitroglycerine and other compounds. The grains of propellant burn at their surface, and after being completely consumed,

the gaseous products of combustion expand adiabatically. The energy of the burned explosive is dissipated in the following ways:

(a) Forward kinetic energy of the projectile and gases.

(b) Rotational energy of the projectile due to rifling.

(c) Kinetic energy of the recoiling parts and carriage.

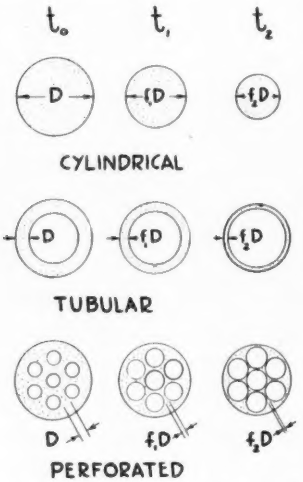


Figure 1. Various shaped propellants at different times during burning.

(d) Resistance of the air to the motion of the projectile within the gun tube.

(e) Heat loss due to conduction through the gun tube.

(f) Sensible and latent energy in the exhausted products of combustion.

Summary of symbols used:

A—Cross sectional area of the bore.

a—Constant in the Le Duc equation.

b—Constant in the Le Duc equation.

C—Weight of propellant charge.

C_v—Specific heat at constant volume.

D — Characteristic propellant grain dimension.

f—Fraction of D remaining at time t.

g—Gravitational constant.

J—Mechanical equivalent of heat.

k—Adiabatic expansion exponent.

L—Propellant force constant.

m—Pressure exponent.

P—Chamber pressure.

q—Propellant form factor.

R—Gas constant.

s—Density of propellant.

t—Time.

T—Gas temperature.

T_0 — Temperature of uncooled gases.

V—Volume behind projectile.

V_0—Initial chamber volume.

v—Projectile velocity at time t.

W—Projectile weight.

x—Projectile travel in gun tube.

z—Fraction of propellant burned at time t.

To obtain the most possible work on the projectile, and hence the greatest possible muzzle velocity, it is desirable to have the pressure behind the projectile as high as possible, and over a long distance since $dW = PdV$. This can only be accomplished by causing the rate of burning of the propellant to increase as the projectile travels down the barrel. This is done by having the burning area of the propellant grain increase as burning progresses. For a cylindrical grain (see figure 1) it is evident that the burning area decreases. With a tubular shaped grain, the burning area remains constant; but with perforated grains, the burning area, and thus the burning rate, increases, until only the slivers between holes remain. This can be expressed mathematically as follows:

(1) $z = (1-f)(1+qf)$

The q factor varies from -1 to $+1$ for various grain shapes; for a tubular section $q = 0$, and for a cylindrical grain $q = 1$. From the above equation, the burning rate is evidently Cdz/dt.

Regressive burning shapes, such as cylindrical, usually burn longer than the perforated progressive type, not only reducing the muzzle velocity of the shot, but also causing "flash" and often spewing forth burning propellant. When using perforated grain, the remaining slivers, which burn regressively, are often eliminated by scalloping the edges of the grain.

The rate of burning also increases with the pressure in the combustion chamber. This may be expressed as

(2) $D(df/dt) = BP^m$

Although m varies from 0.8 to 1.05, the value of 1.00 is usually assumed to simplify the mathematics. The above two equations hold true for the surfaces of the grains being ignited simultaneously.

The next consideration in the chemical energy of the propellant. This is expressed in terms of the maximum temperature of the uncooled products of combustion: $L = RT_0$, and is about 10^7 (fps)^2 for commercial propellants.

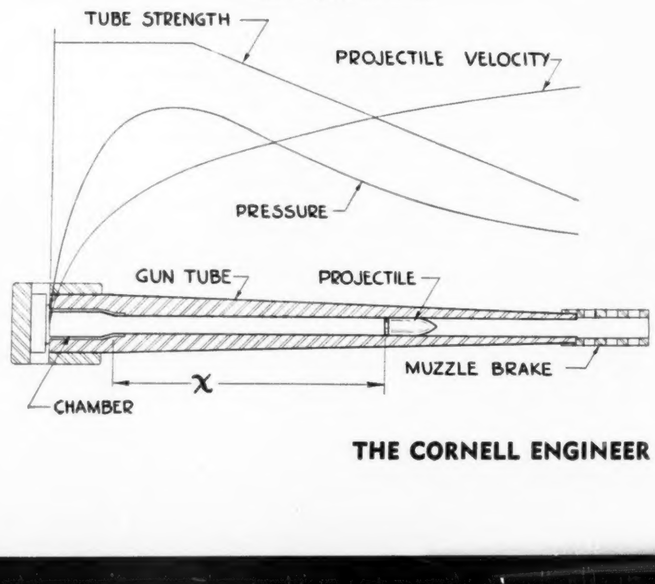
The equation of state may now be written from:

(3) $P(v\text{-}a) = RT$

where a is the covolume factor, to cover variation from the ideal gas law because of the closeness of the gas molecules in the chamber. During firing, the volume between

(Continued on page 30)

Figure 2. Variation of tube strength, chamber pressure, and projectile velocity as a function of projectile travel.



MEN and WINGS

By HOWARD M. BELLIS, ChemE '54

Early Curtiss biplane used by the Navy.

Before a great invention is created, much work must be done, occasionally by one man, more often by many. The invention of the airplane is an illustration of the latter. Wilbur and Orville Wright are almost universally acclaimed as the originators of successful powered flight. But, invaluable as their work was, there were many others who laid the groundwork. Throughout history men have wanted and tried to fly, meeting with few successes and many failures. But long before the twentieth century they were learning.

Men's attempts to fly can be divided into two main classifications: powered craft and gliders. These may be further broken down into models and man-carrying craft. Throughout the history of aeronautics, definite periods may be discerned in which first one and then another of these groups held various men's interests.

At first they tried to reach the skies, both literally and figuratively. Models and gliders had little attraction when contrasted with flying under one's own power. Ancient myths and legends reflect their yearning in tales such as that of Daedalus and Icarus, who modeled wax and feathers into giant bird's wings. As birds were the most obvious flying things, it was natural for men to imitate them. So they concentrated on bird-like ships with flapping wings powered by the muscles of the operator.

Roger Bacon was one of the first to consider imitating bird's wings, but only as a means of propelling a lighter-than-air craft. Leonardo Da Vinci in the thirteenth century made diagrams of wings to be attached to a man's body so that he might fly. Many others conjured up plans of ornithopters, or bird-winged ships, but no serious attempt to utilize them was made until the middle of the eighteenth century. In 1742 the Marquis de Bacqueville attached large paddle-shaped wings to his hands and feet and tried to fly across the Seine. He landed ignominiously in a washer-woman's barge and broke both legs, putting an end to the project.

An English artist named Miller constructed a flying chariot in the shape of a West Indian crow. Spectators thought the motion of the wings in perfect imitation of nature, but the craft never left the ground. Several others attempted to build craft with wings modeled on those of different birds at this time, but the only one to leave the ground was one having elliptical wings covered with strips of cloth similar to the modern ribbon parachute. The ship and its inventor, Jacob Degan, climbed to a height of fifty-four feet. However, ninety of the hundred and sixty pounds of the load were supported by a balloon.

Only at the turn of the century did most men come to realize what a few people had been trying to say for years; that man's muscles simply were not powerful enough to lift himself into the air. But at this time there was no other source of power both strong enough and light enough to serve the purpose. Men were faced with two alternatives; they could turn to powerless flight —gliders—or they could build models powered by available mechanical means and hope to develop an efficient engine for later use. One or two followed the former course, but from 1800 to the 1870's most men chose the latter.

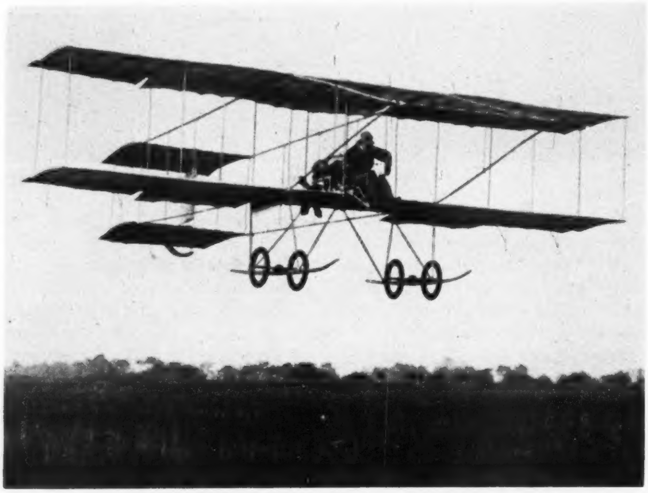
Sir George Cayley, the father of modern aeronautics, followed both. He, like his predecessors, had tried an unsuccessful man-powered ornithopter. But unlike them, he turned to other fields of flight. He was the first to design a working helicopter

model. Twisted rubber bands caused two windmills attached to a vertical shaft to rotate. He built several of these models, and their descendants became popular as toys. One such plaything helped to stimulate the Wright Brothers into experimentation.

Cayley was the first to do extended theorizing. He considered such things as wing loads, initial velocity, bending moments, and the need for lightness and strength. He designed a model powered by propellors and fitted with fixed wings set slightly tilted up toward the front instead of the usual flapping wings. This was the prototype that set the pattern for many future craft.

He also constructed a full-scale biplane glider. Its wing area was three hundred square feet, small by modern standards, but enough to make it the first successful glider. The ship, piloted by Cayley's coachman, was launched from a hill over a valley and covered nine hundred feet, eventually meeting the hill on the other side. The coachman emerged from the wreckage unhurt physically but with enough wounded dignity to cause him to leave Sir George's employ. Cayley never tried to repair the ship; and thus the last important attempt at gliding for many years came to an end.

In 1842, W. H. Phillips made an attempt to use steam as a power plant. He built a twenty pound helicopter with revolving fans inclined at an angle of twenty degrees from the horizontal. Steam generated from the combustion of charcoal, nitre, and gypsum was used in the same elementary way as in Hero's ancient machine, by ejecting it through bent arms causing them to rotate. The model attained considerable altitude and covered several hundred feet laterally. But the extravagant and wasteful use of steam prohibited the engine's use in full scale craft, and most inventors continued to use simpler means, such as rubber bands and compressed air.



Early biplane similar in design to the original Wright brothers model.

Six years later John Stringfellow followed by Cayley's ideas of horizontal wings and built a triplane model. The ship was driven by two propellors and was one of the first to have a tail. Even so, it had little stability and its design showed poor comprehension of aerodynamics. It achieved a flight of sixty feet, but its major contribution to areonautics was its engine, a light, well-designed steam plant capable of powering a better ship.

In 1870 the growth of aeronautics shifted to France where Alphonse Pénaud started experimenting with rubber-driven helicopters. They reached their height of development in his hands. His tastes were catholic, however; he built an ornithopter and a stick body monoplane as well. Both were rubber powered, and the latter flew 130 feet. Pénaud's ships made no great headlines, but served to consolidate previous advancements in the field. But he was a man who looked to the future. "One of his most remarkable achievements was his design for a monoplane amphibian . . . incorporating a streamlined hull . . . stressed skin construction, controllable pitch metal propellors, retractable landing gear, highly polished finish for less air resistance, shock absorbers, full instrumentation (including an automatic pilot), and single stick control." All this was patented in 1876. He tried many times to get backing for the enterprise and finally shot himself in despair over not having been able to get the craft built.

Revives Ornithopter

A notable attempt was made to revive the ornithopter at this time. Gustave Trouvé designed an extremely unusual model that made use of gas from explosions for power. A cylinder was bored to hold twelve charges and a hammer mechanism was designed to fire them one at a time as the cylinder was rotated, in the manner of an automatic pistol. The gases were guided into the center of a semi-circular tube, closed at the ends. There the pressure momentarily straightened the tube out, as in a pressure gage. Fantastic as the ship may seem, it achieved flight exceeding two hundred feet. Its possibilties, however, were more limited even than W. H. Phillips' machine.

Lawrence Hargrave joined the revival on the ornithopters in the 1880's and built some fifty models. He was firmly convinced that flapping-winged ships would fly, even though some of his own more orthodox ships outperformed them. At first he used rubber bands, then compressed air, and finally steam. One steam ship covered 128 feet in eight seconds. Like most of the earlier experimenters, the Australian used a flat instead of a curved wing. This was in spite of the fact that he experimented with bird's wings and airfoils of many shapes.

Throughout the epoch from Cayley to Hargrave, men were concerned with two questions: the relative merits of ornithopter, helicopter, and fixed-wing ships; and the quest for power to drive them. The fixed-wing ship had risen along with the helicopter while the ornithopter, which still defies engineering, declined. Rubber and compressed air, not suitable for large-scale application, were sacrified for steam. But while knowledge of "how" planes flew was growing, knowledge of "why" was not. Little was done after Cayley in the way of theoretical research, without which real progress was impossible. And, during this time, a new epoch was starting—that of the gliders.

LeBris' Glider

Though Cayley's glider was a comparative success, there was only one other gliding attempt of any note before the 1880s. A few intrepid souls jumped from barns with usually a sprained or broken ankle for their efforts. But it remained for a French sea captain named Le Bris to approach Cayley's achievement. Reports of Le Bris' flight are not well authenticated and probably are exaggerated; they were first made public in 1885 in a contemporary novel. Octave Chanute, however, made an investigation and concluded that they were founded on fact. Le Bris' ship was modeled on an albatross. It was launched by being towed by rope from a horse-driven cart. Unnoticed by Le Bris, or so we are told, the driver of the cart became tangled in the rope and was hoisted aloft. Driver, pilot, and plane came to earth an eighth of a mile away after attaining an altitude of three hundred feet. At a later date the captain tried launching himself from the edge of a quarry. An updraft turned him over and he crashed, breaking both legs. Like others, he became discouraged at this point and turned to other fields.

Montgomery Flies

If Captain Le Bris' experiments were of little use in furthering aeronautics, the work of Professor J. J. Montgomery in California contributed a great deal. In his experimentation from 1884 to 1894, he came to suspect the value of curved over flat wing surfaces. He also was aware that pressure was greatest at the leading edge and decreased toward the rear, a fact that did not become an established aeronautical principle until 1910. Professor Montgomery made several flights of from three to six hundred feet. At first he used the orthodox method of launching his craft from hill tops, but later tried launching them from hot-air balloons. One flight was made from an altitude of thirty-five hundred feet, during which Montgomery gave an exhibition of soaring, swooping, and circling. Not to be outdone, one of his assistants warped the wings of the craft and completed two somersaults.

Montgomery also made use of a tandem monoplane type of craft which was to serve as a prototype for later experimenters. Like many, he felt the air currents from two wings mounted one atop the other would interfere with each other and reduce efficiency.

Lilienthal Uses Airfoil

Independently of Montgomery, Otto Lilienthal also experimented with the same curved wings. Lilienthal, a die-hard believer in ornithopters, turned to gliders as a source of information and eventually became completely absorbed in them. From 1893 until his death in a crash in 1896, the German made over two thousand flights. Although his work was improved upon by Pilcher, to Lilienthal belongs the credit of demonstrating the superiority of arched over flat surfaces and of reducing gliding flight to regular practice. He experimented first with monoplanes and then with biplanes. He found the latter furnished him with more stability and better results. All his ships were so constructed as to leave the pilot dangling in a vertical position. His wings, especially those on his monoplanes, gave him a bat-like appearance, for he had not changed to rectangular wings, as had Montgomery. With one ship weighing two hundred and twenty pounds fully loaded, and having a span of twenty-three feet, he flew twelve hundred feet, almost a quarter of a mile.

A young Englishman, Percy Sinclair Pilcher became a disciple of Lilienthal. Pilcher had worked with Hiram Maxim, who will be mentioned later, and afterwards followed the German glider's experiments. Even before joining Lilienthal he had built a small ship, the *Bat*. Using Le Bris' method of launching, he achieved a flight of over a minute's duration. He also built three other ships, combining his experience with what he learned from Lilienthal. But, unlike Lilienthal, Pilcher had little faith in biplanes. All three were monoplanes. In the last of his monoplanes he flew about seven hundred and fifty feet, launching his ship over a deep valley.

Pilcher Killed

In 1899 Pilcher designed a powered ship. In the preceding year he had studied some experiments of Hargrave with box kites and was so impressed with them that he gave up monoplanes and went to the opposite extreme, building a triplane. He had an engine under construction when, in September, 1899, he was killed in a crash during a demonstration flight.

Lilienthal served to stimulate another experimenter, Octave Chanute. Chanute was sixty when he started in 1896 at Dunes Park on Lake Michigan, but age did not affect his scientific ability. He kept excellent notes on all his experiments and even succeeded in taking photographs of consecutive phases of a single flight. His actual flights through the air were less impressive and daring than those of Lilienthal and Pilcher, but he had a better scientific training and more ability as a designer.

Chanute Attains Stability

Instead of trying for records, (his best flight was only 360 feet), he concentrated on what he considered the most important problem in aeronautics: stability. He experimented with five pairs of wings, then reduced the number to three and finally two. Chanute, like Cayley and Lilienthal, found the biplane the most stable and efficient design. It was eventually a biplane that achieved what monoplanes and tandem monoplanes could not: successful controlled flight under power. Even for many years after the Wright Brothers first flew, the

biplane was the only type to fly. Chanute's ship was so stable he occasionally allowed friends to try it. Unlike most previous attempts, his experiments were not marred by accident. In 1896 and 1897 he made over a thousand successful flights.

Power Flight Tried

As the development of gliders reached its prime, men once more began to try powered flight. Toward the end of the century the steam engine was being perfected to a point where it might be feasible as a source of power, more so at this time than for Stringfellow and Phillips. The turn of the century also brought the internal combustion engine, unencumbered by boilers and without the need of open flames. From 1890 through 1903, there were four major attempts at powered flight. Two were made with monoplanes, one with a tandem monoplane, and the final, successful one, with a biplane.

The first attempt is still partially obscured by the secrecy that surrounded it. Clement Ader, aided by the French Government, built two ships that many feel deserve the credit given that of the Wright Brothers. Ader's adherents claim that he made two successful flights, one of a hundred and sixty-four and the other of a thousand feet. On both occasions the flights were carried on in secret. The first ship, the *Eole,* was tested in 1890. It had a wingspan of 46 feet and weighed four hundred and forty pounds. Two witnesses claimed that the ship covered over fifty meters in the air. In any event, the ship crashed and was damaged beyond repair at the end of the run.

A second ship, the *Avion,* was then built. It was slightly larger than the *Eole* and, like it, had wings modeled on those of a bat. In 1897, seven years after the first flight, the *Avion* was tested before members of the French General Staff. The ship was supposed to follow a chalk line, but a crosswind arose, and it was carried a good distance to one side. Some witnesses believed that the ship flew the distance. Others felt that the cross-wind caught the ship and carried it, finally dumping it end over end, destroying it in the crash. The French Government evidently felt that the ship was capable of flight, whether or not it had flown. They gave Ader more funds to continue his work and suppressed news of the attempts until after the Wright Brothers had flown.

Two other experimenters, Sir Hiram Maxim and Professor Steven Langley were also doomed to unsuccessful attempts. In each case their ships were capable of flight but were never completely airborne because of mishaps. And in each case their failures brought much needed aeronautical information to light. The gliders had proved the efficiency of arched over flat wing surfaces, and they had developed elementary ideas of stability. But quantitative theories were sadly absent for the most part, and, when present, were based on outdated ideas. Maxim had the greatest contempt for almost any aeronautical theory other than his own. He felt that "nearly all the mathematicians are radically wrong, Professor Langley, of course, excepted." He made elaborate dynamomter tests with propellors at different speeds. He constructed a wind tunnel and then a whirling arm to test airfoil sections and parasite drag. He was convinced that the propellor was the most efficient means of propulsion, better than anything in nature. " . . . and no doubt there would have been fish with screw propellors, providing that Dame Nature could have made a fish in two pieces." He also found that wings could support a much greater weight than had previously been supposed.

Maxim Builds His Ship

Maxim did not do things half-way in building his ship. It was one hundred and forty-five feet long, one hundred and four feet in span, and had a gross weight of four tons. A third of this was the weight of the wheels and carriage, for Maxim did not intend the ship to fly until fully tested. It was powered by a three hundred and sixty horsepower steam engine. In order to conserve water, exhaust vapors were piped through the steel tubing framework to be cooled and reused. The ship was run on eighteen hundred feet of track set down on his estate at Bexley, Kent, England. Despite its weight, the ship showed a marked tendency to rise from the track. So Sir Hiram added two more wooden rails above the wheels to keep the ship from rising more than a few inches. Throughout 1893 and 1894 he ran tests on the ship, adding and subtracting wing surfaces.

Finally he opened up the engine to a boiler pressure of three hundred and twenty pounds. Two-thirds of the way down the track the wheels tore the wooden guard rail loose and the ship started into the air. Rather than risk free flight, Maxim cut off the steam and came to a crash landing. He had put a great deal of money into the machine and gave the project up rather than invest more in repairing it.

Langley's Experiments

Where Maxim had started with the very large, Professor Langley started with the small. Working with the Smithsonian Institute, Langley began with variations of Pénaud's powered models. But he had less success than the Frenchman, and so turned to indirect experimentation. Like Maxim, he relied largely on his own figures and also used a whirling arm to test various shapes and designs. He came to Pilcher's earlier conclusion that the monoplane was more suited for flying than the biplane and also gave up all sources of power except steam for his subsequent models. He built eight *Aerodromes* of about twelve to fourteen feet span. The first five were failures, mostly due to insufficient power. The sixth managed flights of six or seven second's length, and the last two proved successes. In 1896 he was finally able to send one ship 3200 feet.

Up to this point he had not intended to go beyond models. But, stimulated by the Spanish-American War, the War Department offered him a grant of fifty thousand dollars to develop a full scale ship. He accepted it.

Langley at once felt the need for a better and safer source of power than steam. Accordingly, he and his assistant, Charles Manly, an engineer of Cornell University, set out to obtain a gasoline engine of sufficient power. They contracted with

(Continued on page 34)

Propane - Fuel of Tomorrow

Already Used by Buses, May Soon Be Installed In Autos

By HENRY F. DIMMLER, EE '54

Gasoline, long enjoying a monopoly in the motor-fuel field, is at last being challenged by a petroleum by-product. The challenger is propane—also known as liquified petroleum or refinery gas. Once considered as a useless "drug-on-the-market" product by refiners, propane is stepping to the fore as an internal combustion engine fuel for trucks, railroad equipment, buses, and tractors. It has firmly entrenched itself in these commercial fields, and now looms as a possible super fuel for the knockless, high-powered automobile engine of the near future.

Propane Wasted

Back in the 1920's propane—considered a dangerous and useless by-product of the petroleum industry—was burned in large flares at the refinery. Thrift-conscious petroleum engineers realized that refinery profits were literally going up in smoke from these propane torches, and set out to find a market for the unwanted product. Since the characteristics of propane roughly parallel those of natural gas, the first market explored was that of gas refrigerators, stoves, hot water heaters and house heaters—all of which had successfully been burning natural gas. Bottled in large metal pressurized cylinders, propane soon expanded to the commercial fields of food processing, farming, and industry.

Converts To Propane

Finally, in 1930, propane invaded the motor fuel field and soon proved that it was there to stay. Transcontinental truckers, railroads, tractor and stationary engine users all converted to propane operation and proved it a successful fuel under the most trying operating conditions. Despite the remarkable performance of propane as a motor fuel, its use was limited until World War II when a severe shortage of gasoline prompted commercial consumers to find a less strategic, substitute fuel.

Excellent Performance

Propane was the answer and the liquified petroleum gas market grew tremendous almost overnight. Performance figures soon proved that propane was indeed a new super fuel with a bright future. It is now cutting deeply into the gasoline monopoly in all internal combustion engine fields. A fleet of 500 propane-operated buses is now operating in Chicago. Transportation companies throughout the United States are embarking on conversion programs for buses and trucks. Conversion of farm tractors and heavy construction equipment is progressing rapidly with a resultant high return on initial investment. Indications are that the automobile is next in line for the switch to propane.

What claim has propane to the title of "super fuel?" Performance figures tell the story. Perhaps the most important figure to the motor fuel users it its price. In many localities, propane undersells gasoline by ten cents per gallon, tax included. But, economy doesn't stop here. Being a dry gas, propane eliminates thinning of lube oil and resultant cylinder scoring. It has been proved

Schematic diagram showing the method of supplying and carburezing propane.

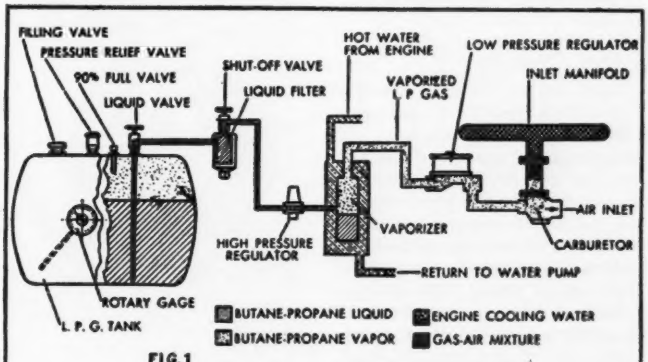
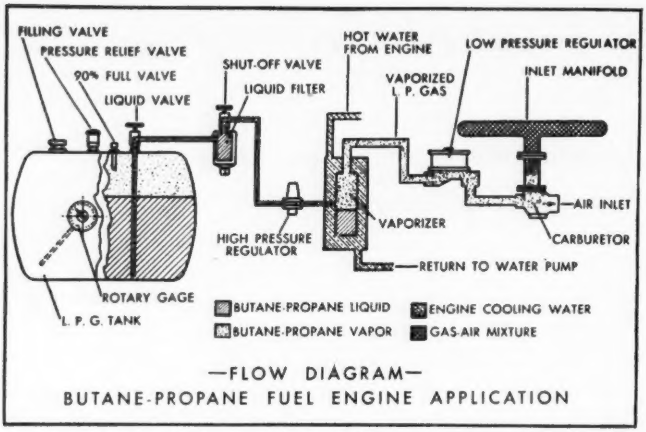


FIG.1

—FLOW DIAGRAM—
BUTANE-PROPANE FUEL ENGINE APPLICATION



Above is a diagrammatic picture of the flow-path of propane from high pressure fuel tank until it is finally injected in the cylinders.

conclusively that lubricating oil can be run from five to six times longer when using propane as the engine fuel. The saving in oil alone is quite a large item!

Uniform Carburetion

Propane is stored under pressure as a liquid in the fuel tank. When reduced to atmospheric pressure just prior to carburetion, it changes state to a perfectly dry gas. A thorough mixing of this dry gas with air takes place and the result is a uniform distribution of fuel and air throughout the manifold. With a wet fuel, such as gasoline, this uniform mixing and distribution is never attained. The overall effect of this improved carburetion is to provide smoother power impulses and to eliminate crankcase dilution entirely.

Exhaust Odors Reduced

Since propane is more completely burned than gasoline, harmful carbon deposits within the engine are eliminated and exhaust smoke and odors are virtually nonexistant. Cold weather vaporization problems also are eliminated since propane remains in the vapor state down to —44°F at atmospheric pressure. Its high octane rating (125 as compared with 85 for good grade motor gasoline) makes possible engines with compression ratios up to 14-1. Knocking or detonation is eliminated and a resulting power increase of up to 20% is made possible by this doubling of the compression ratio over the present gasoline engine.

This smoother-burning fuel greatly decreases wear and tear on engines, with resulting decreased maintenance costs and longer engine life. A heavy-duty trailer truck engine, run 250,000 miles on propane, exhibited cylinder wear equal to 30,000 miles with gasoline when finally overhauled.

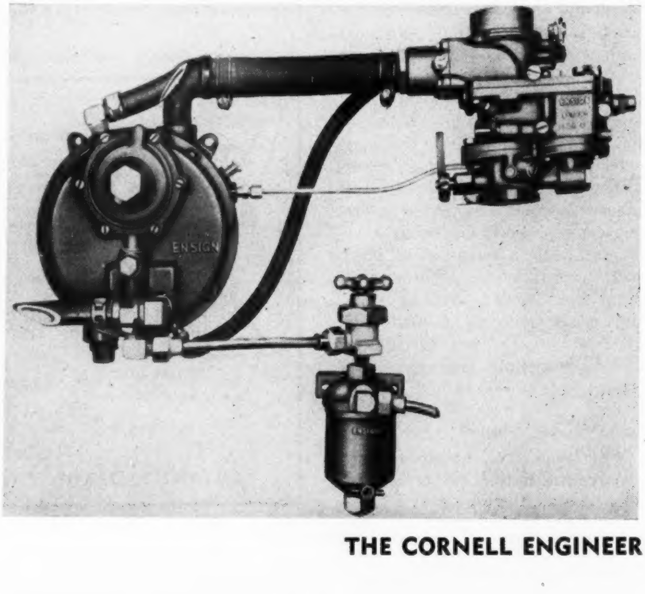
One disadvantage of propane is its low heating value. While the heating value of a fuel has little effect on power output, it is a direct measure of the quantity of fuel required—the higher the heating value of the fuel, the lower the quantity of fuel required to do the same work. The heat value of propane is about 92,000 B.T.U. per gallon, compared with 130,000 B.T.U. for motor gasoline. Propane consumption is therefore somewhat higher than gasoline. However, it has been proven that propane engines operating at 10-1 compression ratio will give the same mileage per gallon as a conventional gasoline engine with 7-1 compression ratio.

Storage Difficulties

Another disadvantage is the difficulty of transporting and storing propane. Since it must be stored under pressures up to 250 psi, heavy steel tanks and gas-tight lines are required. At present, the demand for motor fuel propane is not very great and thus filling stations are few and far between. However, as demand increases, servicing fa-

(Continued on page 36)

The combination propane and gasoline carburetor and propane regulating unit pictured below provides for either propane or gasoline operation of the engine. Liquid propane enters the filter (lower center), travels to the propane vaporizing and regulating unit (left) and thence to the downdraft combination carburetor (far right). For gasoline operation the valve above the propane filter closes off the L.P. gas flow and a second valve admits gasoline directly to the carburetor.



News of the College

John T. Parson Dies

John T. Parson, professor emeritus of engineering drawing and the man for whom the Johnny Parson Club on Beebe Lake is named, died on April 28 after a long illness. He was 80 years old.

Professor Parson began his career at Cornell in 1895, when he was appointed an instructor in Civil Engineering. He first came to Ithaca, though, in 1893 to work with Estevan Fuertes, then head of Civil Engineering, on plans for Brazilian sewers. He spent about a year here, returning to an engineering office in his native Washington and then came back to Ithaca to work on the plans for Ithaca's sewer system.

He was associated with several of the E. G. Wyckoff industries and formed the Armstrong Company, his own enterprise, for the manufacture of portable school houses. Several of these were sold in Tompkins County including the school building that formerly stood on Cornell Heights, and the Ithaca Reconstruction Home school building.

Professor Parson will be remembered best by Cornellians for the active part he took in developing Beebe Lake as a winter sports arena. He was the first man to clear the snow from the ice for skating and had much to do with building the first two toboggan slides. The University acknowledged his efforts in the development of the winter sports program by naming after him the club on the west end of the lake which has long since grown to be a Cornell tradition.

Professor Henriksen Article

A technical article on metal cutting by Prof. E. K. Henriksen, head of the department of materials processing at Cornell, appears in the May issue of the "Transactions" of the American Society of Mechanical Engineers.

Professor Henriksen gave his paper on "The Stress Distribution in the Continuous Chip" at the semi-annual meeting of the ASME in St. Louis a year ago. In an appendix he presents a theory developed since that time.

Professor Burrows Dies

Earle Nelson Burrows, associate professor of structures in the School of Civil Engineering, died unexpectedly at his home on May 6. He was 68 years old and would have reached retirement age last June.

Professor E. N. Burrows

Professor Burrows received the degree of Civil Engineer from Cornell in 1907, and was awarded the Master of Civil Engineering degree in 1914. He became an instructor in the School of Civil Engineering in 1911, was made assistant professor of structures in 1915, and promoted to associate professor in 1941.

He had wide experience as a consultant, particularly in the field of steel construction, and served for many years as consulting engineer to the Ithaca Board of Public Works. From 1907 to 1908 he was design engineer for the Owego Bridge Company and from 1908 to 1910 for the American Bridge Company of Gary, Indiana.

In addition to his teaching duties, Professor Burrows served as secretary of the engineering faculty and as a class adviser. During World War II he taught defense training evening courses in Elmira and Binghamton. He was a member of Seal and Serpent, Chi Epsilon, national honorary society in civil engineering, and the American Society of Civil Engineers.

Areo Lab Research

Sharply inreased activity, reflecting mobilization research for the military services, was reported by Cornell Aeronautical Laboratory in a year-end review.

An applied research center, the laboratory devotes about 95 per cent of its efforts to development projects for the armed forces. It is a self-sustaining, non-profit corporation with 100 per cent of the stock held by Cornell University.

Dr. Theodore P. Wright, vice president for research at the University and president of the Laboratory, said the Korean conflict and national mobilization had resulted in an increase in the facility's annual volume from $3,600,000 in 1949-50 to $4,500,000 in the past year. To handle the heavier load, he reported, the staff was increased from 575 to 675 during the same period.

Dr. Wright disclosed that the laboratory is at work on 130 different projects and has a backlog of about $8,500,000 in research contracts.

Although most of the research is "classified" for security, the report indicated that work is being done in guided missiles, armament and similar fields.

Among the non-classified research, Dr. Wright listed projects ranging from a study of atmospheric electricity to the development of an improved aviation combat helmet. He included investigations of helicopter performance, air traffic control and other phases of air

(Continued on page 42)

Cornell Society of Engineers

107 EAST 48TH STREET — 1951-52 — NEW YORK 17, N. Y.

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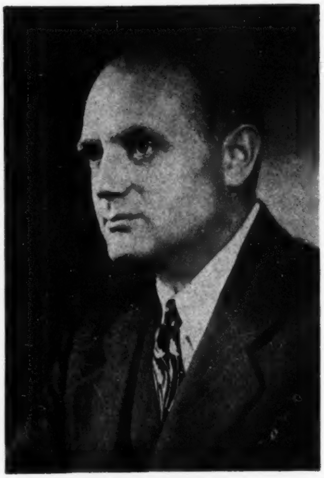


Frederic C. Wood

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish closer relationship between the college and the alumni."

President's Message

The effectivenesso of most volunteer or non-paid organizations depends on three factors—

1. Having a sound purpose;
2. The extent of the finances;
3. The interest of the members.

Obviously these all overlap. Let's examine the Cornell Society of Engineers in these respects.

Here is the formal statement of our purpose. "The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish a closer relationship between the college and the alumni." It is a broad statement but the meaning is clear. Through association as engineering alumni we want to keep engineering at Cornell and engineers from Cornell in the pre-eminent place we have always known them to be. Our incentive may come from nostalgic loyalty to our great institution or from our pride about her or from a purely selfish angle of wanting to be identified professionally with a top notch school. In any case the purpose is still sound.

As to finances, we are fair. We balance our budget—with a struggle. Our activities, however, feel the strong restriction of our purse. There are many things we could do if we had more funds. This coming year of inflation will be particularly difficult. As hat passing is not one of our techniques, the only answer is more members.

May I urge you to suggest to Cornell engineering friends that they join. The subscription to the Cornell Engineer alone is worth the three dollars. If that isn't enough, then consider the $3 as a contribution to furthering the cause of engineering at Cornell—what cause could be nobler? We'll throw in for free the value of the association with other Cornell engineers or the meetings or the placement service. If you, individually, could help us get *one* more member, it would be a genuine service and our financial problem would vanish.

As to our membership interest, it is good but we could use a lot more of it. During the coming year try to get out for our meetings. They are not frequent enough to be boring or burdensome to busy people. If you are not already a member of the Society come out anyhow and we'll hope that the sample will induce you to join. With your interest and your help we can make this year another one of progress for the Cornell Society of Engineers.

Alumni News

Fred C. Perkins, M.E. '01, of the Perkins Battery Co., York, Pa., has filed a patent on a method of preventing or minimizing grid corrosion in batteries. It is based on a principle of deoxidation described in "American Metal Market" for March 2.

Glenn B. Woodruff, C.E. '10, was recently named by Dean Crawford of the University of Michigan as one of the three engineers who had bee most successful in the design of long-span bridges. The Carquinez Straits Bridge, the Rip Van Winkle Bridge across the Hudson, the San Francisco-Oakland Bay Bridge, the Shasta Dam Bridge and many more less-known works of utility and rare beauty perpetuate the name of Glenn Woodruff, both as a designer and a consultant.

Since 1944, he has been a partner in the firm of Woodruff & Sampson, consulting engineers of 171 Second Street, San Francisco. Along with plenty of bridge work, his professional activities have included such interesting jobs as the harbor improvements at Mazatlan, Mexico, and a master plan for the solution of San Francisco's transportation and utilities problem.

G. B. Woodruff

Mr. Woodruff is married and lives with his wife at 2417A Ellsworth Avenue, Berkeley 5, Cal.

Carl V. Burger, B.Arch. '12, has completed three large murals of fish, seals, and aquatic life for the New York Zoological Society, which will be installed in the new aquarium at Coney Island when it is completed.

John W. Hill, M.E. '16, is senior vice-president and head of the trust department of the First National Bank & Trust Co. of Bridgeport, Conn. He lives at 340 Collingwood Road, Bridgeport 4.

A. Griffin Ashcroft, M.E. '21, has been appointed vice-president of research and development for Alexander Smith & Sons Carpet Co. in Yonkers. He has been with the company since 1933 and was previously director of research and development. Last spring he visited textile firms in France, Holland, Germany, and Switzerland to discuss two industrial processes, which Alexander Smith uses. He also presented a paper, "Industrial Research and the Consumer Target", at the annual conference of the Textile Institute in Brighton, England and then visited textile firms in the British Midlands and Scotland. He lives at 37 Garden Avenue, Bronxville.

John P. Syme, M.E. '26, senior vice-president of Johns-Manville Corp., 22 East Fortieth Street, New York City, has been made a member of the Quarter Century Club, honor society of persons with more than twenty-five years service with the company. Syme joined Johns Manville upon graduation and has since held positions in general engineering, market analysis, research in prefabricated housing methods, sales promotion, employee and public relations, and was recently vice-president in charge of industrial relations for a J-M subsidiary. He is a past president of the Cornell Society of Engineers and a governor of the Cornell Club of New York. Mrs. Syme is the former Helen English '26.

A. G. Ashcroft

Gordon Kiddoo, B.Chem. '43, is assistant director of the National Research Corp. petrochemical research department in Cambridge, Mass. and is in charge of engineering economics for his department's program with Electric Bond & Share Co.and United Gas Corp. He had been director of research and development for Continental Carbon Co. of Amarillo, Tex.

Chester H. Brent, Jr., B.E.E. '50, is a development engineer with Hyton Radio & Electrronics Corp., cathode ray tube division, in Newburyport, Mass. He married Margaret A. Burkhart, graduate of Stephans College and University of Tennessee, December 23, 1950. They live at 7 Dawes Street in Newburyport.

Techni-Briefs

Magnetic Storms

Evidence that a direct relationship exists between magnetic storms on earth and the position of planets with respect to each other and the sun has been disclosed by John H. Nelson, radio wave analyst of R.C.A. Communications Inc.

According to the new theory these disruptive forces may be forecast months or even years ahead of their materialization, thus permitting ample time to select the best radio channels to avoid curtailment of traffic.

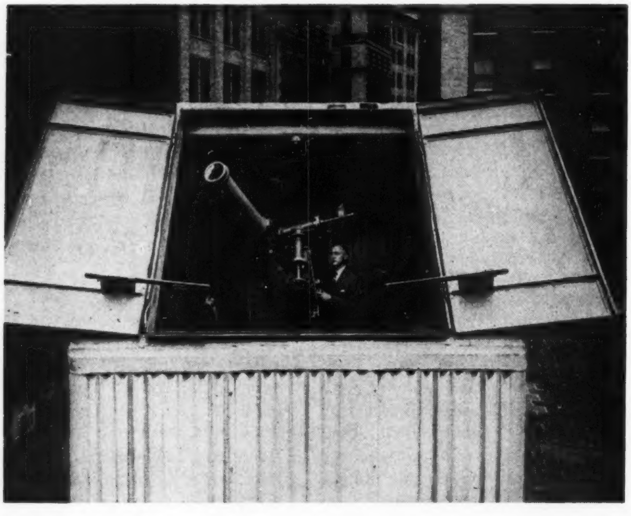
Based on Mr. Nelson's predictions for the 1951-52 winter season, selection has already been made by R.C.A. for the best working radio routes and frequencies of its world wide radiotelegraph circuits to be used under the radio weather conditions forecast for that period.

The conclusions reached in this report were the result of nearly five years of studying radio wave behavior in relation to sunspots and the movements of planets. Using a six inch telescope in the heart of New York's financial district, Mr. Nelson daily plotted the position and characteristics of sunspots on the solar surface.

It was during the observation of sunspots that he became convinced that besides their activity other forces acting upon the sun also affected the magnetic weather conditions upon the surface of the earth. This conviction led him into research involving the exact position of the planets with respect to the sun.

From this observatory in the heart of the financial district of New York, Mr. Nelson has discovered a new theory of magnetic storms.

—*Courtesy R.C.A.*



Giant Windtunnel

Providing enough power to generate supersonic blasts of air several times the speed of sound will be the job of a giant 180,000 horsepower wind tunnel drive now being built by the General Electric Company. The special motor unit, the most powerful electric drive of its kind, is being constructed for the National Advisory Committee for Aeronautics for installation in a new wind tunnel at Ames Aeronautical Laboratory, Moffet Field, California.

The 180,000 horsepower installation will consist of four 45,000 horsepower motors arranged in tandem on a single shaft. Largest of their kind ever built, the motors will each weigh more than 145 tons, and each will be about the size of a modern living room. The drive will have a peak one hour output of 216,000 horsepower.

Linked to the drive system of the motors will be two compressors, each about seventeen feet in diameter which will produce the supersonic air streams for the actual testing. These compressors are similar in shape and in operating principle to the compressors in jet engines, except that they are much larger.

New Length Standard

The availability to science and industry of an ultimate standard of length has been announced by the National Bureau of Standards and the Atomic Energy Commission. The standards consist of spectroscopic lamps containing a single pure isotope of mercury. These lamps enable any research organization which has the auxiliary optical equipment to have for the first time an ultimate primary standard of length in its own laboratories.

The lamps contain about one milligram of mercury of atomic weight 198, obtained by the transmutation of gold in a nuclear chain reacting pile. Natural mercury is a mixture of seven different isotopes, which, when caused to glow brightly by the application of high fre-

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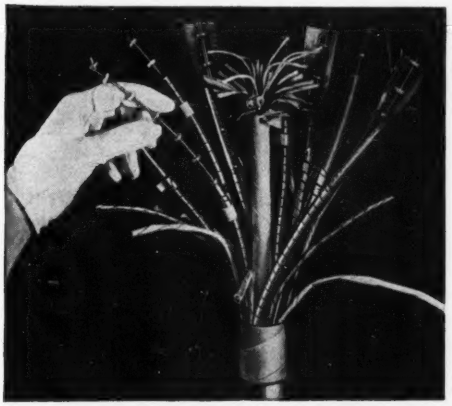
Newsworthy Notes for Engineers

Between the gloved fingers, you see the plastic discs which separate and insulate inner wire from outer tube of coaxial unit.



Plastic "life-savers" For Coaxial Cable

(ACTUAL SIZE) 

In every mile of new eight-unit Bell Telephone coaxial cable there are over half a million little plastic insulating discs. They look simple enough—like small plastic "life-savers"—but there's a lot of engineering behind them.

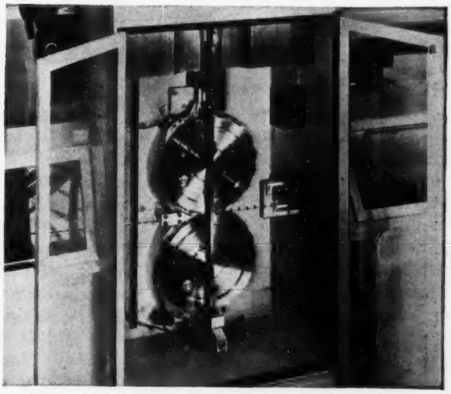
In early coaxials, the insulators were made of hard rubber. But scientists at Bell Telephone Laboratories found that polyethylene—because of its extremely low power factor and lower dielectric constant—reduced shunt losses to about one-twelfth of those with rubber discs.

Use of polyethylene plastic, however, required the development by Western Electric—manufacturing unit of the Bell System—of unusual handling techniques and special machinery.

Punching the discs, with a neat hole in the center, from sheets of the tough plastic is routine. To position them on the coaxial conductor accurately and speedily is not so simple. Equipment was designed and built which receives the discs from a hopper, forces each against a knife edge to slit it, and slips them on to the wire at regular intervals of one inch. At the same time another part of the machine forms copper tape into a tube around the wire and discs, gives a high voltage test, and wraps the tube with two spiral layers of steel tape to produce a completed coaxial unit.

Before the discs go into the machine, they are subjected to an "ozone atmosphere" and to the radiation from radium salts to remove static electricity which would cause them to stick together and refuse to enter the feeding tracks.

All of this — the development of new production methods and machines, the infinite care in manufacture — requires engineers of many kinds—electrical, mechanical, chemical, metallurgical, industrial. Working closely together, they help to convert scientific developments in communications into economically manufactured products for the Bell System.



Plastic insulators, fed into this mechanism, are slit — and pressed on to the coaxial conductor exactly one inch apart.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

(Continued from page 18)
quency radio waves, emit a mixture of light of seven different wave lengths. The isolation of a single isotope has made it possible to obtain light waves of an extremely sharply defined wave length. Length measurements based upon it can be made with an accuracy of one part in 100 million.

Although the world's official primary standard of length is still the distance between two lines on a metal bar, practically all precise measurements of length in this century have been made and will continue to be made with light waves. When accuracy greater than the one part in ten million possible with the standard meter is necessary, only the new spectroscopic standard meets the need.

Celestial Sliderule

Quick and easy computation of aircraft performance data required by engineers and pilots is possible on a new slide rule developed by engineers of the Douglas Aircraft Company testing division.

Appropriately named the Sky Rule, the six-inch, light-metal, pocket slide rule is designed to give "on the spot" answers to common aeronautical problems, without reference to voluminous text books and charts.

It has in addition to the conventional "C" "D" and "A" scales, 20 other scales peculiar to aviation, which are not found on any other single device. Scale markings are theoretically accurate to one ten-thousands of an inch, the manufacturer declares.

With the Sky Rule it is possible to determine at a glance the Mach number, true air speed, indicated air speed, density altitude, temperature rise and numerous other aeronautical functions.

Two scales permit conversion from degrees Centigrade to corresponding Fahrenheit readings and two additional scales convert from miles-per-hour to knots. Conversion factors also cover several relationships in the English and metric systems.

The Sky Rule is 6" x 1-3/32" x 3/32" in size. The warp-proof light-metal core maintains accuracy in moisture, heat and cold. The white surfaces make the black, needle-sharp scales easy to read. Manufacturing and sales rights have been granted to Pickett & Eckel, Inc. of Chicago, Ill.

Supercold Bottle

A vacuum bottle that can hold the world's coldest liquid fifteen times longer than the best container previously available has been developed at the Westinghouse Research Laboratories in Pittsburgh. The new copper vacuum bottle will hold four gallons of liquid helium at a temperature of only eight degrees above absolute zero for more than three months.

The new bottle consist of two highly polished copper spheres—

—Courtesy Westinghouse Corporation

Measuring the temperature inside the new low-temperature vacuum bottle.

one inside the other—about a foot in diameter. Most of the air is evacuated from the area between the two spheres. The bottle is immersed in a tank of liquid nitrogen at –300 degrees Fahrenheit to minimize heat losses. The heart of the new device is contained in the long narrow neck tube through which the liquid is poured. Since practically all of the heat transmitted into the interior of the bottle is conducted down the surface of the neck tube, the neck was designed to cut these losses to a minimum. This was done by making the tube slightly more than a half-inch in diameter, increasing its length and using thin-walled metal. Through such design, the heat inflow was reduced by 90 per cent.

The super-cold helium vapors coming from the container serve to refrigerate the neck tube. This essentially neutralizes the transmitted outside heat and thereby narrows the temperature gap between the tube and the helium. By improvements in the design of the tube even more efficient containers may be developed.

Until now it has been necessary to ship liquid helium as a gas and then liquefy it at the point of use. The new vacuum bottle makes it possible to ship it as a liquid, thus effecting savings of both space and materials.

Magnetic Ore Concentrator

An improved type of magnetic separator, to aid in concentrating low grade iron ore from Minnesota's famed Mesabi Range, has been developed by Jeffrey Manufacturing Company of Columbus, Ohio, with magnetic design assistance from the Westinghouse Electric Corporation. The new device is part of a long-term project to assure the nation of ample domestic ore supplies after Mesabi's high grade ore is used up.

The new ore separator operates on a somewhat different magnetic principle than previous devices of its type. It consists of a rotating drum mounted in a pulp box of special design. Stationary magnets inside the drum provide the means whereby iron ore is extracted from the taconite, a formation of 25 per cent iron and 75 per cent rock.

As the mixture passes beneath the separator's rotating stainless steel drum, the magnets draw the magnetic iron ore from the mixture to the drum. The movement of the drum carries the ore through a washing zone and then away from the direct pull of the magnets, depositing it in a trough leading to further grinding stages.

The entire magnetic separation process calls for grinding the taconite in stages, passing the partially-ground ore through the new separator between grinding stages in order to eliminate barren rock from the system. Then the finely ground material mixed with water is passed through another type of magnetic separator in order to make a final separation of the iron mineral from the ore. The final product is dewatered on filters and is ultimately

(Continued on page 38)

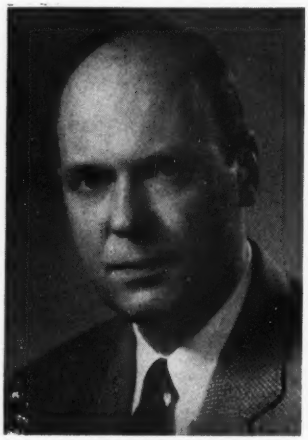
Faculty Profile

Andrew Schultz

At first glance, the office at 23 West Sibley looks like that of any engineering professor. It is small, with its one window facing out on the Quad. Bookcases and a series of cubbyholes occupied by partly corrected and not yet given prelims line one wall; graphs of various colors and sizes cover the other. But if one takes more than a cursory glance at the room, he is struck by the fact that the titles of many of the books ("The Financial Policy of Corporations" sits beside a volume of personnel management) would seem equally at home on the shelves of an arts college or law school professor. The office is, of course, that of Professor Andrew Schultz, head of the department of Industrial and Engineering Administration.

Professor Schultz is a conservative man both in stature and in dress. In conversation he is soft-spoken, but at the same time very interesting, a trait which most of his students agree he carries over into his classes. Behind this quiet front, however, there is a great deal of energy and drive which is evinced in many of his classroom antics. Beside conducting his regular classes and carrying on the major share of the department's business affairs, Professor Schultz participates actively in numerous faculty activities. Together with Professor Martin Sampson, he has been doing placement work for the graduating ME's, a position which has enabled him to become very well acquainted with his students. But, his interest in student affairs extends deeper than merely finding them jobs. Just after the last war, when student interest in extra-curricular work lagged badly, he took a leading role in promoting campus activities, for one of the things that makes Cornell engineering great in his eyes is the broad scope of outside activities engineers can and do get into.

Professor Schultz is a native of Boston. After spending four years in a local prep school, he came to Cornell (he found M.I.T. too close to home), where in 1936 he received his B.S. in A.E. degree. When asked about his college activities, he replies, "Just the usual engineering stuff." This, in the case of Professor Schultz, included membership in Tau Beta Pi and serving as president of his fraternity, Phi Gamma Delta. He was also a member of the advanced R.O.T.C. from which he received his reserve commission.



Professor Schultz

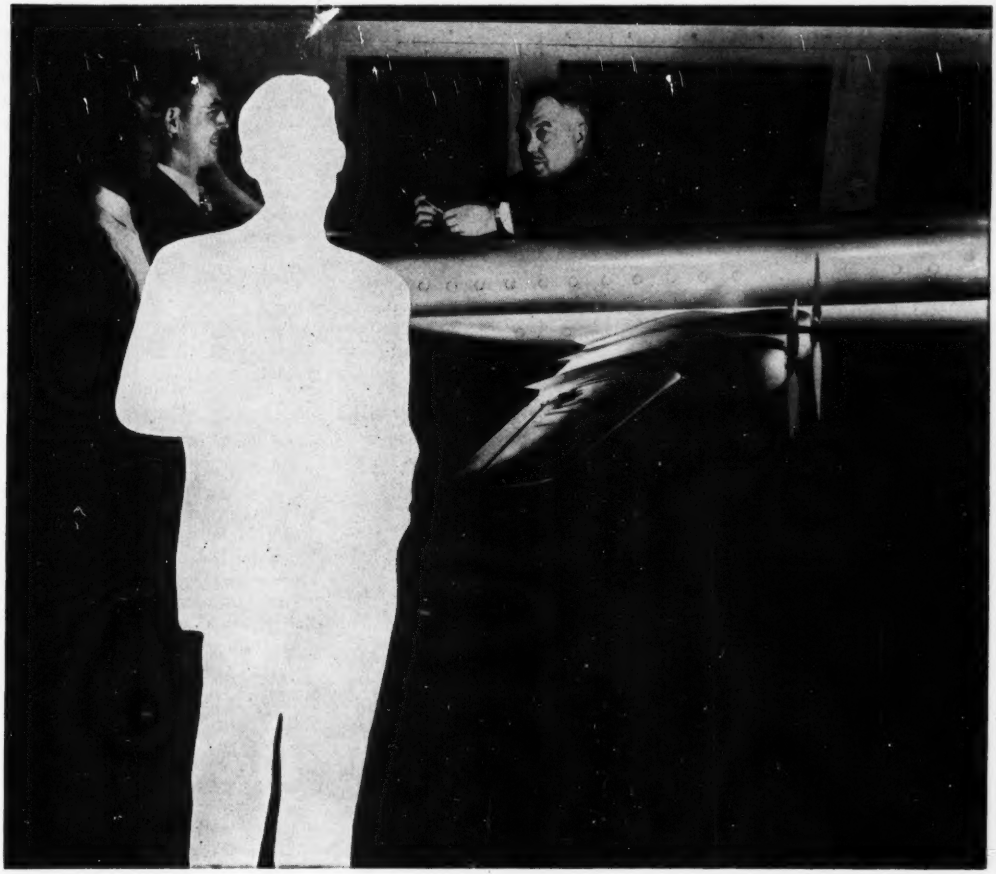
Upon graduating, he went to work for New Jersey Bell Telephone for a year, where he served as a lineman, installer, and repairman. It was here that Professor Schultz learned to chew tobacco, purely a temporary expedient used to keep from being overcome by fumes as he worked over smelter plants. He decided the work was not for him, and so returned to an instructorship at Cornell, where he also undertook graduate work. He received his doctorate in 1941, three days before he was called up from the reserve into active service.

The war years saw him doing industrial service work for Army Ordnance, a job which carried the responsibility of setting requirements and production schedules. He also allocated the production of bombs, explosives, chemicals, etc., to the various services and foreign allies. It was a long and tiring job with constant complications, and 1946 found him only too glad to return to civilian life and the University.

The major function of the Department of Industrial and Engineering Administration is to provide courses for mechanical engineers in Option B. This course prepares students for entering the manufacturing and industrial phases of engineering work. The Department's aim is to superimpose sound methods of application upon a strong engineering background. The Department had its beginning in courses presented about the turn of the century, though it did not exist as such until the twenties. It has also been consolidated with courses in other departments wherever overlapping has occurred, and now has a faculty staff of about twelve. Professor Schultz is convinced that the present program is equal to that of any in the country.

Away from the University, Professor Schultz does his best to lead a quiet, ordinary life. He enjoys a good game of golf and putters around in his garden during the summer. His many activities cut into the time he would like to devote to his hobbies, but nevertheless he occasionally indulges in some woodworking. He is married and has a two-year-old daughter who keeps the family toeing the mark. Yet, whenever the rare opportunity presents itself, the Schultzes enjoy traveling to other places "just to see what's going on."

As Professor Schultz is still in the Ordnance Reserve, he views the current world situation with as much apprehension as any college student. But, barring any future call from the service, he intends to stay at Cornell for quite some time. And a good thing it will be for the University, too. It can well use men of his ability.



PROMINENT ENGINEERS

Dick Rippe, ME

When Dick Rippe graduated from high school in Detroit, Michigan, he decided, since he had always enjoyed science and math, to follow in his father's footsteps and became a mechanical engineer. He entered Cornell in 1947, the recipient of a Cornell National Scholarship, and lost little time in justifying the award by virtue of his interest in campus activities and excellent schoolwork.

The record he has amassed here well bespeaks the enthusiasm Dick has for his studies. Eighth in a class of over one hundred, he has always maintained good grades and has made Dean's List several times. He has duly been elected to Tau Beta Pi and Pi Tau Sigma honorary societies and is also vice-president of Atmos, the mechanical engineering social fraternity.

Dick has a good deal of practical experience, most of which he picked up during summer vacations, to go along with his classroom work. After his freshman year he worked on a steam boiler construction project for the Detroit Edison Co. The following summer he was employed as a student engineer on the construction of a power plant for the same company. Last summer, however, proved to be the most interesting and exciting of all. His stepfather, Walker Cisler, M.E. '22, is head of the power system rehabilitation program for ECA in Europe. Hence, Dick was given the wonderful opportunity to go to Greece and work there on a power project. What better way to combine pleasure and accomplishment during a vacation?

Dick's large muscular frame readily belies the fact that he is an avid sportsman. He has participated actively in football and track, concentrating on discus and javelin in the latter. He enjoys sports for recreation too, golf and skiing being his favorites. When asked what he shoots in golf, he will only claim that his game isn't as good as it should be. Dick also spends much of his spare time listening to jazz and performing his duties as an active member of Phi Delta Theta.

When he graduates in June he would like to continue the same type of work he has been doing during summer vacations. Steam power plants and absorption refrigeration interest him most.

Dick

Robin Westbrook, Arch

Cornell cannot, of course, be classed as the ideal school for all students. However, to find a good example of how well the University can suit an individual you don't have to look much further than Robin Westbrook and the record he has compiled in his four years at Cornell.

Robin was born in Texas and began his higher education there at Austin College. At that time, he was interested in both art and mathematics, and, being unable to choose between the two, sought to combine them. He chose the latter as his major but retained a plan to eventually go to an eastern university and study art there. Success came early to Robin as he was admitted to Alpha Chi, a 'small college' Phi Beta Kappa, while still at Austin.

He entered Cornell as a freshman in 1947 after completing three years at Austin. From the start, Robin entered into Cornell's extra-curricular program and distinguished himself with his work. So far, he has been a member of Octagon, the Sophomore, Junior and Senior Class Councils, Frosh Orientation Committee, Senior Week Committee, and designed the 1951 Junior Blazer pocket emblem. In addition he has served as Art Editor, Assistant Editor and Editor-in-Chief of the *Cornellian*.

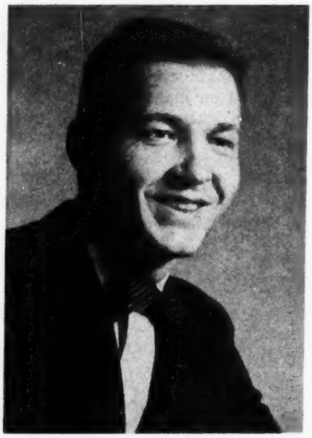
Professional and scholastic honorary societies have not overlooked Robin either. He is a member of Tau Beta Pi, Pi Delta Epsilon, Sphinx Head, Scabbard and Blade, and Gargoyle and L'Ogive, the latter two being Architecture honoraries.

You might have easily guessed by now that Robin has also done well in his studies at Cornell. In fact he has been first in his class since his Freshman year and last year was awarded the Scipp Prize in Architecture for submitting the best design in a class problem.

His social life centers around Delta Tau Delta fraternity and he has helped his house on numerous occasions with artistic designs and creations.

Robin graduates in 1952 and has already begun to think about his future work. At present he seems to favor designing private homes rather than commercial architecture. It seems certain, however, that whatever field he enters, his career will be a successful one.

Robin



EDITORIALS

For Less Cheating

The recent highly publicized dismissal of many cadets from the Military Academy at West Point forcibly brought before the public the problem of cheating on examinations in institutions of higher learning. To a certain extent, the incident has disillusioned many who believe that West Point, and for that matter all colleges, harbor the finest of American youth who supposedly are to adhere continuously to the high American morals of honesy and selflessness. Whether the standards of conduct for college youth are too high is not the question. The fact remains that various forms of cheating exist whereever examinations are given. And while it is true that certain portions of the elder generation have set an extremely poor example, this certainly does not sanction or condone a general degradation of ethical conduct, collegiate or otherwise.

Soon to be made public is a survey taken at Cornell by the Student Council concerning the reasons for cheating on examinations. Actually it is sufficient to say that the cause is a desire for a higher grade than otherwise possible for the purpose of retaining a scholarship, of preparing for a professional school, or for just remaining off probation; and coupled with unpreparedness caused by a heavy social life, excessive activities, or a degree of incompetency, the average student, much less the active student, certainly has sufficient motivation for attempting to obtain aid. But every day people are motivated toward immoral if not illegal action. Why then does a student, who would never even think of passing a red traffic signal, toss off his scruples and succumb to this temptation?

Of course the answer is not simple. But it is illuminating to note that apparently there is a double moral code in existence, which forbids a man from wronging his neighbor, but which encourages him to cheat the larger, more soulless organizations, such as governments and large corporations. For instance, the Bureau of Internal Revenue has found that one in four income tax statements contain various large errors, always in favor of the taxpayer.

Apparently then, the average university fits into this heartless and impersonal category, and professors are disrespected to such a point that a student does not feel the twinges of his conscience as he peers over his neighbors shoulder during a quiz.

It appears that rectification of the situation must be attacked from two points: first, it is time for introspection of the part of the colleges as to whether they have become too mechanized and the professors too distant from the students. As for the second part, it is high time for college youth to drop their adolescent and irresponsible habits, and start to acquire that which his college education is attempting to give him above all else —a mature mind.

G.W.S.

Welcome Freshmen!

It is a pleasure to welcome you to Cornell as members of the Freshman Class in Engineering.

I am sure that you have come to realize that you are entering now the most important phase of your preparation for a lifetime career. The direction and shape of your future very likely will be determined to a considerable extent in your next five years at Cornell. This will become evident even in the first period of your professional experience, but especially as you work toward professional maturity twenty or thirty years hence you will find that you will have to depend upon your academic background as the foundation for your growth. These next five years are, therefore, the most vital investment for your future.

This thought has guided us in developing the curricula you are about to undertake. They are distinctly professional in scope and purpose, designed to give you the strength in the fundamentals of science and engineering upon which you can build your technical proficiency. In addition they provide for general studies which will stimulate your intellectual development and help you to acquire the personal qualities needed for leadership. We want you to take your place among the many Cornell Engineers who have gained distinction both as engineers and as leaders in human affairs.

I hope you will keep these broad objectives in view. As you go about your daily activities it will be easy to become completely absorbed in the accomplishment of that day's demands—to make that lesson or that course an end point in itself. It is well to apply yourself completely to the job at hand and to make your progress step by step, but I hope you will take time also to stand back and look at the overall pattern of your activities. Much of the value of your efforts here will depend upon your ability to master each study for its own purpose, and then to integrate all of your learning into a solid core of knowledge for your professional career.

I congratulate you on the opportunity that is before you. The College will watch your progress with warm interest and will assist you in every way to achieve a full measure of success.

S. C. Hollister, Dean
College of Engineering

Dean S. C. Hollister

Book Review

"MATERIALS ENGINEERING OF METAL PRODUCTS" by Norman E. Woldman. Published by Reinhold Publishing Corporation, New York in December 1949. Price $10.00.

In the formal training of an engineer much time is usually spent in courses dealing with the design of machine elements and machines where the stress analysis aspect is emphasized. Additional time is also spent in the study of materials, particularly metals, where the emphasis is placed on the fundamentals of their structures. One of the most difficult things to accomplish is the correlation of these two fields of study which would enable the desinger to more fully understand what materials he can use to best advantage and the metallurgist to know more about the service conditions under which the metals he develops must work. The author of this book has made an extremely worthwhile contribution to the literature which will eventually bring about this much needed correlation.

Typical of the chapters which are helpful in bridging the gaps between the design of the part, the materials used and the service conditions imposed is the one on gear materials. A brief review of a descriptive nature covers the various types of gears required by industry. This is followed by a discussion of such subjects as gear terminology, requirements of a gear in service, and selection of a gear material. Next is a group of sections devoted to gear steels and the various heat treatments used, cast irons, bronzes, powdered metals, welded gears, and the various nonmetallic gear materials. The chapter concludes with a discussion of the durability of gear teeth, types of wear encountered, methods of failure, lubrication, and gear design.

Other chapters of this general type cover spring materials, bearing materials, threaded fasteners, electrical contracts, and thermostat materials. Specific applications are also dealt with in other chapters which have more general titles such as magnetic materials, electrical resistance alloys, corrosion-resistant materials, and high temperature materials. These chapters and those mentioned in the preceeding paragraphs constitute the most valuable part of the book.

The remaining chapters contain data on properties of metals, corrosion, and methods of testing, which, while of some value, can be found in most handbooks, textbooks, and other literature on materials.

P. E. Kyle,
Professor of Metallurgy

ENGINEERING ECONOMY. By H. G. Thuesen, Head, School of Industrial Engineering and Management, Oklahoma Agricultural and Mechanical College—501 pp. Prentice-Hall, Inc., New York.

Just previous to receipt of Professor Thuelen's new book on Engineering Economy, the reviewer had been reading some of the details of the proposed Federal Budget of over seventy billion dollars. It is gratifying to read the book and learn that at least someone in the U.S.A. is still thinking of the most economical way to do things and that arithmetic is not yet a lost art among our people.

The Thuesen book presents no radical departure from the concepts and methods of treatment of engineering economy as established by pioneer writers in the field, such as Eugene L. Grant. One receives the impression that the new writer had made a very thorough survey of the existing literature on the subject and we encounter here and there familiar citations from other sources for which due credit is mentioned. However, the text is not simply a compilation from other sources; the author uses his own language and many new and valuable examples and problems are presented.

A good case is made for the necessity of economic studies as a part of the basic education of engineers. In the course of 18 chapters, the author sets forth the fundamentals of interest, depreciation, equivalence, estimates, costs, comparison of alternatives, replacements, accountting, personnel, public activities, and associated matters in a sound manner.

Personally, I think the usefulness of the book in the field of engineering education would be more widely extended if adequate consideration had been given to certain policies. One policy is that of a better general economic background. At the expense of shortening some of the other material, it would be helpful to insert a brief chapter showing, mainly by charts, what has happened in this country during the past fifty years with respect to inflation, national income, construction costs, population, interest rates, growth of government control, effect of wars on prices, frozen rentals, and price controls. These are the things which greatly influence every business man and responsible engineer in making day-to-day economic decisions. I would hesitate to introduce a student to the economic comparison methods set forth by Professor Thuesen without first making certain that the student had immediately in front of him this broad record in order to at least appreciate the risks involved in reaching a solution.

Another feature restricting the general engineering use of the book is that insufficient attention is given to the special needs of the civil engineering student, although an effort has been made to introduce a few simple examples in that field. With most economic problems, the civil engineer spends 80% of his time on estimating construction costs, some more time on estimating future receipts from anticipated traffic and other uses, and only a small amount on the economic comparison based on these estimates. Maybe it is too much to hope that the text book should include procedure and detail on such methods of estimating. Possibly the only answer in a course on Engineering Economics is to require the student to obtain two separate text books.

Carl Crandall
Associate Professor of Civil Engineering

Interior Ballistics

(Continued on page 8)

the breech block and the base of the projectile is the sum of the chamber volume and the bore volume, minus the remaining unburned portion of the powder:

$$(4)\quad V = V_0 + Ax - C(1\text{-}z)/s$$

Since the weight of gas generated at any time is Cz, from equation (3) we get:

$$(5)\quad P(V_0 + Ax - Cn) = CzRT$$

where $n = 1/s - a(1\text{-}1/s)z$. Now, by the conservation of energy, and neglecting losses, it is evident that:

$$(6)\quad Jcv(T_0 - T)Cz = \tfrac{1}{2}Wv^2/g$$

By substituting the expressions for T and T_0 in equation (6), the following relation is obtained:

$$(7)\quad fCz - P(V_0 + Ax - Cn) = \tfrac{1}{2}\,(k\text{-}1)\,Wv^2/g$$

The above equation was first used by Resal in 1864. By using this with equations (1) and (2), it is now possible to find the velocity of the projectile and the chamber pressure at any time. Another analytical approach is to use the Newtonian law of motion instead of the energy equation. We may assume that the charge is moving with an average speed one-half that of the projectile speed. Thus:

$$(8)\quad (W + C/2)dv/dt = AP$$

and with equations (1) and (2) and unique solution is again possible. If the use of equation (7) or (8) is too complicated, everything may be simplified by assuming an equation of the projectile velocity, such as the Le Duc expression:

$$(9)\quad v = \frac{ax}{b + x}$$

The constants a and b are found experimentally, and an approximate solution to the general problem is posible with equation (8). Figure 2 shows the variation of velocity, pressure, and tube strength as a function of projectile travel.

The correlation of theoretical predictions with experimental results is good but not perfect. It is here that the analytical rather than the LeDuc method becomes a more valuable tool; by adjusting one or more of the constants, correlation may be made perfect. Thus, in many applications, the grain form factor q is found to differ from its "geometric" value, indicating that simultaneous ignition of the grain surfaces is not occurring, and that the theory of burning only at the surface is also somewhat inaccurate.

Improvements Made

Nevertheless, analyses of this type have led to several improvements in gun design. Recoil of the gun tube can be minimized by the use of muzzle brakes, which use the momentum of the escaping gases to slow down recoil by turning the velocity of the gases through ninety degrees, or by allowing the gases to escape through the rear of the breech after a certain pressure has been reached.

The pressure-distance curve of figure (2) reveals that after a certain point, increasing the muzzle length does not increase the muzzle velocity to any great extent, because the gas pressure has been reduced by expansion. To minimize this expansion, the Germans have used a conical-shaped bore, with the smaller diameter at the muzzle. The projectile was fitted with flanges that folded down as it traveled down the bore.

Other Propellants

The use of other than solid propellants is being experimented with also, the most notable being liquid oxygen as the oxidizing source. Experimental techniques are constantly being improved by the use of the high-speed oscillograph and the high speed motion camera. The fininal aim, of course, of all this research is the highest possible muzzle velocity with the least bore erosion, the latter severely limiting the life of a gun.

To many, it may seem unfortunate that such an apparently inhuman science as ballistics exists. In defense it can only be said that nothing in this world is neither good nor evil; it is only the use that Man makes of it.

TAU BETA PI PRIZE ESSAY

By VINCENT PARE E.P. '51

When one listens these days to a discussion of engineering curricula, he finds that the topic most frequently brought up and most vigorously debated is that of liberal courses.

Those who find other than discomfort in the awkwardly shaped chairs of the "Arts College" will describe the typical engineer as an uncultured, unculturable individual who thinks he is going to a trade school instead of a university, and who will be very little of a social asset to his community. These remarks are true to a disturbing extent.

At this juncture one of the accused puts down his iron-carbon phase diagram and informs his audience that he and his friends might well show some interest in their "arts" courses were it not for the disorganized lectures, dull subject matter, and unfairly graded tests to which they are subjected. There is a definite odor of sour grapes in these statements, but they are nevertheless also true to a disturbing extent.

Here then, is a situation which vitiates very seriously the effectiveness of the current liberalization of engineering curricula in many colleges. What is to be done about it? Is the whole attempt worth the effort? There is no doubt that the answer to the second question is yes. The failures of our world to organize itself peaceably and the many unfinished struggles for social and economic justice going on in our own relatively happily organized country are an unmistakable sign that more emphasis is needed on the non-material phases of human development, particularly in the minds of such influential people as engineers.

Once the severe necessity for such an emphasis is clearly seen, there is no question as to whether or not the engineering colleges can contribute toward it by improving their curricula. The only pertinent question is how to go about it, so as to overcome the maladjustments brought out in the first few paragraphs.

Before attacking this problem it is necessary to recognize that the typical engineering student is a different individual from that for which most liberal courses are designed. There is no doubt that he lacks much of the aptitude and interest characteristic of the success-

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Men and Wings

(Continued from page 12)

an engineering firm to develop a twelve horsepower engine weighing one hundred pounds. The company could not fulfill the contract, so Manly set out to build the engine. He made almost all the parts himself, as others refused to believe his demands could be met. He finally presented Langley with a fifty-two horsepower engine weighing only 125 pounds, a fantastic 2.4 pounds per horsepower. This figure did not become common until many years later.

During this time Langley built his ship. It was a tandem monoplane having a span of forty-eight feet and a weight of 730 pounds. It was equipped with a double rudder. Manly's engine was geared to two propellors. The ship was to be launched from a houseboat on the Potomac by means of a catapult.

The first test was made on Oct. 7, 1903. As the plane, piloted by Manly, took off, it hit a part of the launching mechanism. It was deflected off its course, causing it to crash into the river. It was fished out and repaired for another attempt on Dec. 8, two weeks before the Wright Brother's flight. This time the tail structure failed and again it crashed. Unfavorable comment appeared in the press, and the War Department decided not to invest any more money in the project. Like those of Maxim and Ader, Langley's ship was capable of flight. In fact, it was flown under the direction of Glen Curtiss in 1914.

Wright Brothers

Logically, we must put the Wright Brothers in a class, not with Langley, Maxim, and Ader, but with Chanute and the other gliders. The first contact Wilbur and Orville had with aeronautics was with a descendent of Cayley's helicopter. They built several of their own, but then gave them up as childish. News of Lilienthal's death started them thinking about flight again. They felt that Lilienthal and Chanute were right in seeking to solve the problem of stability before attempting power flight. At first they experimented with box kites, and then in 1900 built their first glider. It was a biplane modeled on Chanute's.

Improvements Made

But they were not content just to copy. They introduced two great improvements; the elevator, or horizontal rudder, which they placed in front of the wings; and the flexing of the rear edge of the wings so as to vary the lift on one side or the other to gain stability. They also placed the operator in a horizontal position instead of vertical. They built a second, larger ship that managed to fly 300 feet. It, too, was a biplane.

But the Wrights found marked discrepancies between the results of their performances and those of the other gliders. According to their data, their flights should have been much better than they were. Accordingly, they built a wind tunnel and began to experiment. After two years they decided that their data, correlated with that of Maxim and Langley, was sufficient. Late in 1902 they built a third biplane. This ship proved very stable and flew over 600 feet.

Finally they felt that they had overcome the problem of stability and were ready for powered flight. They strengthened the ship and added a twelve horsepower gasoline engine weighing 180 pounds, considerably less efficient than Manley's engine. This drove two propellers by means of bicycle chains. The ship was launched on a monorail track with Orville piloting it on December 17, 1903. It took off into a twenty mile-an-hour wind with Wilbur running alongside to steady it. Once off the ground, the ship behaved erratically, bobbing up and down. After twelve seconds it darted downward and ended its flight some one hundred twenty feet from its start. By noon they had made four flights, the last of 852 feet. The Wright Brothers had flown and landed undamaged.

Men had at last succeeded in flying. But credit belongs not only to the Wrights, but to Cayley, Pénaud, Lilienthal, and Langley, and all the others who laid the groundwork to make flight possible. It was their work that flew at Kitty Hawk.

Propane

(Continued from page 14)

cilities will also increase in number. If propane should be adapted for use in automobiles, it would be as easily obtained as gasoline is today.

Redesign Necessary

Present gasoline-fired engines cannot be converted to propane operation merely by changing fuel tanks. Several engine changes must be made before propane operation is possible. Several large engine manufacturers are now producing engines designed specifically for propane operation. At present these engines are for use only in the heavy commercial fields such as bus, truck, and tractor. However, as propane operation is perfected for lighter engines, it is probable that automobile manufacturers will fall into line, producing an engine designed specifically for propane operation.

Conversion of present gasoline-burning truck, bus, and tractor engines to propane is now progressing both rapidly and successfully. Automobile conversion would involve essentially the same steps as those now being used in converting these heavy-duty engines.

Conversion Steps

The first step in conversion is removal of the conventional gas tank and installation of a welded steel propane tank capable of withstanding pressures up to 500 psi. (One conversion unit now on the market provides for either gasoline or propane operation from separate fuel tanks. Opening and closing tank valves to the carburetor gives the operator a choice of either of the two fuels for engine operation. However, economies realized from straight propane operation are partly eliminated when using this conversion since the engine must be so designed that it can efficiently burn *either* propane or gasoline). This pressurized tank contains the necessary filling and safety valves. In addition, a safety valve in the fuel line automatically shuts off the fuel supply if a sudden drop in line pressure occurs due to a rupture somewhere between the tank and intake manifold.

Next in line along the supply line from tank to manifold is a liquid filter designed to eliminate all foreign matter possing through the fuel line. After filtering, the liquid propane (still at tank pressure) enters the primary or high pressure regulator. Here the gas is reduced to a uniform pressure of approximately 8 psi gage. The resulting low pressure gas then feeds into the vaporizer where hot water from the engine block directed around the vaporizer changes the propane to a dry gas. The third step in the fuel passage from tank to cylinders is the final or low pressure regulator. Its purpose is to further reduce the vaporized propane pressure to slightlv below 1 atmosphere. Basically this low pressure regulator serves the same purpose as the float bowl of a standard gasoline carburetor. It also contains the engine idling mechanism. Actuated by the

(Continued on page 38)

Propane

(Continued from page 36)

partial vacuum created by the downward stroke of the piston, the regulator valve opens sufficiently to allow just enough fuel to pass into the carburetor.

The fourth and last step in the process is carburetion. Working closely with the low pressure regulator the carburetor takes the dry gas and combines it proportionately with air to give a wide range of fuel mixtures. Carburetors designed for propane operation may be mounted either in updraft or downdraft position since the fuel is a dry gas.

In addition to this fuel supply system, complete propane engine conversion also requires several motor modifications. In order to take advantage of the high octane rating of propane, a new high compression cylinder head must be installed and the compression ratio should be proportionately raised. Recommended compression is from 100 to 150 psi gage, depending on cylinder characteristics of the particular engine. Ignition timing must be tested and reset if necessary. Colder spark plugs are usually necessitated by the compression change. The intake manifold is replaced by a specially designed "cold" propane manifold.

The complete propane conversion ranges in price from $200 to $300. This may sound like a large investment. However, initial consumer reports indicate that savings on fuel, oil, and maintenance bills will return this investment within one to two years.

The propane motor fuel market has successfully passed through the neophyte stage of development and is closing in on the highly competitive gasoline market. Of course, the usual "kinks" characteristic of such a new application remain to be ironed out. Nevertheless, ingenuity and research have placed a new and better high octane fuel at the disposal of internal combustion engine operators. The promise of lower costs and better over-all engine operation seem to assure its permanence in that field.

Techni-Briefs

(Continued from page 20)

processed into small round lumps.

These are nodules containing 64 per cent iron, are already being produced at the rate of 200,000 tons per year at the Aurora, Minnesota plant of the Erie Mining Company. The steel industry expects the production figure to be raised to equal present ore output by the time the Mesabi's high grade ore is exhausted.

Hay Fever Relief

Sufferers of asthma, chronic colds and hay fever may, at last, find some relief by using new ion controllers which make indoor air similar to outdoor air at its best.

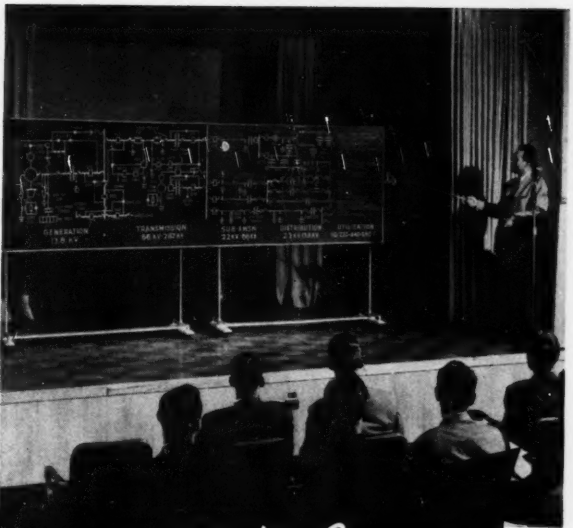
Although the medical profession has known for some time that negatively ionized air breathed by humans has a therapeutic effect on certain ailments, it has only been recently that scientists have developed a method of providing negative ions without objectionable ozone and nitrous oxide.

Devices known as ion emitters are arranged to filter out positive ions while negative ions are carried into the room by air currents passing through the units. The principle of the heater is simply that stale air is drawn in through the bottom of the unit and the ion rectified air is released through the top.

Research studies were commenced on this project in 1939 at Stanford University Electrical Engineering School of Palo Alto, in conjunction with engineers of Wesix Electric Heater Company. Tests have shown that the new type of radiant convection type heaters, operating on ordinary house current, generate these necessary ions without harmful effects. A simple means for screening out positive ions and selecting negative ions for distribution in the household has also been developed.

Very stimulating results have been uncovered by research in this field. The project has uncovered so many unlooked-for effects, that controlled clinical investigations are now being sponsored at five recognized universities and medical schools throughout the country.

In the new Westinghouse Educational Center, engineers and scientists who are top-ranking men in their field explain the company and show how your college training will be used. You have a voice in choosing the field for which you are best suited from the many that are available at Westinghouse.



The Westinghouse Plan

...to help you choose the Right Career

Time is precious to you. False starts, second guessing and indecision are costly.

We have devoted years of study to develop dependable ways to help you get set in the right career.

The Graduate Student Training Program is the result. This is the medium for orientation and training of technical and professional men coming to Westinghouse from colleges. From this training program come most of the key personnel in technical, commercial and supervisory positions throughout the company.

This program gives an understanding of Westinghouse, its products and operations; shows how your college training may be applied at Westinghouse; and helps each man, with the assistance of trained counsellors, to find the type of work for which he is best fitted.

The result pays off . . . to you . . . to us. For more information about the Westinghouse Plan, send for a copy of our book—"Finding Your Place in Industry". A copy will be sent without obligation. G-10166

EDUCATIONAL DEPARTMENT

YOU CAN BE SURE...IF IT'S

Westinghouse

To obtain copy of "Finding Your Place in Industry", consult Placement Officer of your university, or mail this coupon to:

Mr. J. H. Spraggon
District Educational Co-ordinator
Westinghouse Electric Corporation
40 Wall Street
New York 5, N. Y.

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Tau Beta Pi Prize Essay

(Continued from page 32)

ful liberal arts student; otherwise he likely would not be in engineering.

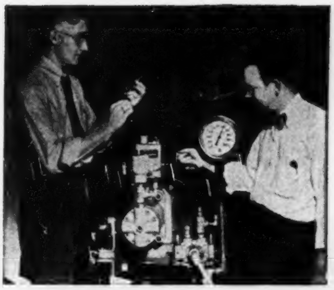
Yet it is fundamental that his interest must be captured if he is to be induced to think about non-technical issues. This can be done by emphasizing those aspects of the subject matter which appeal to his self-interest and his relatively systematic, quantitative ways of thinking.

For example, in studying psychology the engineering student cares little for such topics as perception, consciousness, vision, and hearing, but would have much more use for a study of interpersonal relationships and group dynamics, which will help him in his future personal and social relationships. The former topics are desirable subject matter for those who plan to study psychology more deeply, but are completely irrelevant to the purpose considered here.

Another course commonly required for engineering students is economics. The textbooks used for one such course are of high-school level and not up to date; presumably the lecture material is of the same description. In any case the subject would be much more stimulating if approached from the standpoint of money flows between sectors of the economy, with emphasis on the successful operation of the economy as a whole. There should be extensive discussion of recent and current problems and measures for dealing with them.

These examples have been given as suggestive of the sort of improvements that might be made. In addition a considerable improvement can be effected by allowing time for at least a few elective liberal courses. In short, an engineering curriculum cannot be designed by merely juggling requirements in already available courses. A creative approach is required, which takes into account the interests and capabilities of the student. Only when this is done can a liberalized curriculum go far toward achieving its purpose.

THE DU PONT DIGEST



Ralph C. Grubb, *B.S.M.E., Tennessee '51, and Paul D. Kohl, B.S.M.E., Purdue '46, study characteristics of a super-pressure pump (75,000 p.s.i.) designed by Du Pont engineers and made in Du Pont shops.*

M.E.'s AT DU PONT

Diversity of chemical products spells opportunity for the mechanical engineer

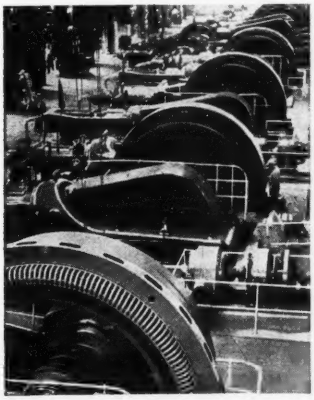
Students of mechanical engineering sometimes assume there is little opportunity for them in the chemical industry. In fields where products are made in more or less standardized equipment, this may be so.

But in a company like Du Pont which operates in many fields of industrial chemistry—where products are made at pressures over 15,000 pounds per square inch as well as in vacua low as two millimeters of mercury—mechanical engineers are in heavy demand.

What jobs do they fill at Du Pont? Literally hundreds, not including the normal run of mechanical engineering work such as design of standard equipment, scaling up from blueprints, etc.

For example, here are some of the problems encountered in the manufacture of nylon yarn alone:

1. Nylon polymer, a poor thermal conductor, is melted by a contact surface grid at 550°F. The polymer decomposes slowly at this temperature, and there is a major heat-transfer problem. Many types of melting grids had to be designed before one proved satisfactory.



The compression *stages of these 50 ton/day hypercompressors (15,000 p.s.i.) for nitrogen, hydrogen, etc., were designed by Du Pont mechanical engineers.*

2. The molten polymer is pumped to spinnerets under pressures over 1000 pounds per square inch. With nylon as the only lubricant, the pumps must operate continuously at 550°F. Specialized problems in sealing, gasketing and materials of construction are inherent in this operation.

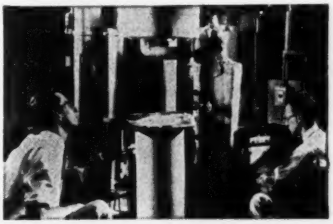
3. The melt is forced through multiple holes (diameters of 7 to 22 thousandths of an inch) in a special alloy disc. They must be made to conform to "jeweler's specifications."

4. The emerging fibers are cooled in a specially designed "air conditioned" chimney. Precise control is essential in this critical operation.

5. The fibers are wound on spools at surface speeds around 1000 yards per minute. Design calls for constant change in speed so that there is no localized stretching or relaxation of the fiber.

6. Finally, the fiber is drawn about 400% and wound on spools traveling at 5000 feet per minute. Bearing lubrication and dynamic balance presented important design problems.

These are but a small part of the mechanical engineering problems arising in the manufacture of a single product by only one of Du Pont's ten manufacturing departments. Literally hundreds of other products, ranging all the way from cellulose sponges to metals like titanium, present similar challenges. So long as new processes continue to be sought and old processes improved, there will be important work for the hand and mind of the mechanical engineer.



Heat-transfer *problems in the design of new fiber-spinning equipment are investigated by J. C. Whitmore, B.S.M.E., Virginia '44, M.S.M.E., Delaware '49, and L.B. Collat, B.S.M.E., Georgia Tech '50.*

Uniquely designed *adapter for a screw extruder under study by Ralph J. Covell, B.S. M.E., Purdue '49, and John F. Bowling, B.S.M.E., Purdue '41. The adapter heats, filters and forms polymer into filaments.*

Send for your copy of "The Du Pont Company and The College Graduate." Describes opportunities for men and women with many types of training. Explains how individual ability is recognized and rewarded under Du Pont plan of organization. Address: 2521 Nemours Building, Wilmington, Delaware.

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING ...THROUGH CHEMISTRY

Entertaining, Informative — Listen to "Cavalcade of America," Tuesday Nights, NBC Coast to Coast

College News
(Continued from page 15)

safety, jet engine performance, parachute stabilization and aircraft takeoffs under heavy load from small fields.

Aero Papers Presented

Scientists associated with aeronautical research at Cornell University contributed three of ten papers by American authors at the third international conference of the American Institute of the Aeronautical Scientists and Royal Aeronautical Society of Great Britain in September.

The American papers and ten others by British authors were given at the joint sessions in Brighton, England, September 3-14.

William Milliken, head of the flight test section at the Cornell Aeronautical Laboratory, Inc., in Buffalo, is the author of a study of "Dynamic Stability and Control of Aircraft." Another, on "Aerodynamics of Wing Body Combinations," is a joint effort of A. H. Flax, head of the areodynamics section at Buffalo, and assistant, William Lawrence. A third paper, on "Flight Safety," is by Jerome Lederer, director of the Daniel and Florence Guggenheim Aviation Safety Center at Cornell.

Dr. Theodore P. Wright, vice president for research at Cornell and president of the Aeronautical Laboratory, represented the laboratory at the sessions.

Argentine Scholarship

An Argentine student will attend Cornell University each year with the help of a new scholarship established by the Cornell Club of Buenos Aires, Argentina.

The club, under the leadership of President Ernesto Lix-Klett, Cornell '08, has set up a fund that will provide the full living expenses of the student. Cornell will give free tuition under its foreign student tuition scholarship program.

Lucio Ramon Ballester of Buenos Aires has been selected for the scholarship for 1951-52. He completed his undergraduate work at the Universidad Nacional de Buenos Aires and has been admitted to Cornell as a graduate student in industrial engineering.

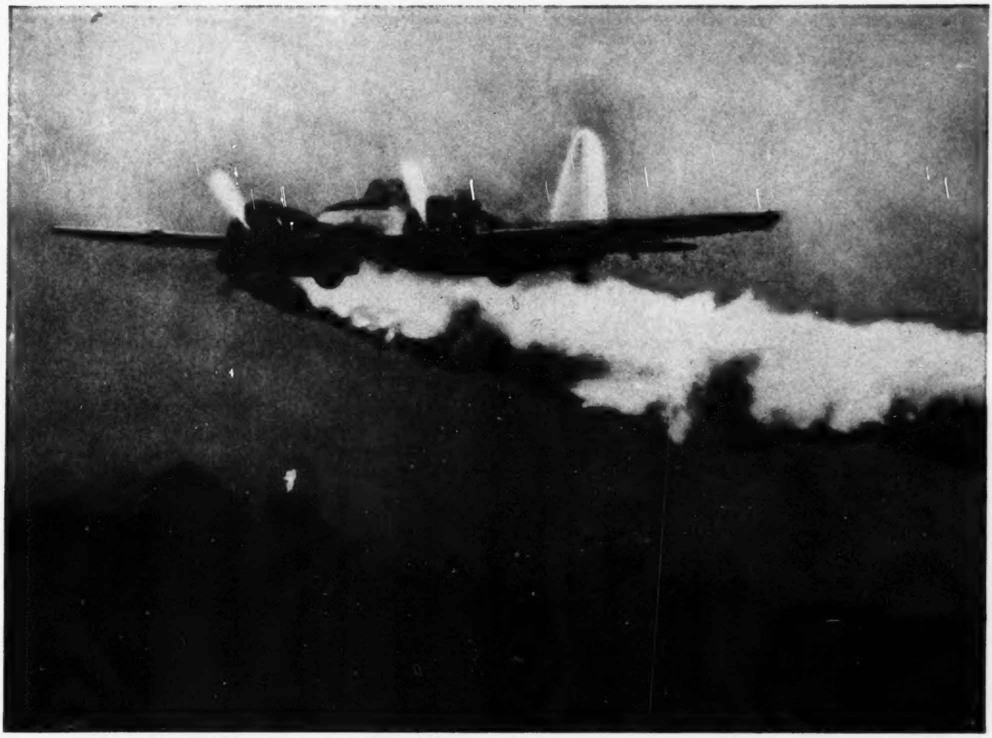
Materials Building

Gifts of $1,175,000 toward a $1,736,000 Materials Testing and Processing Laboratory under construction at Cornell University were announced at the initial meeting of an alumni commtitee formed to seek funds for the engineering center.

"Completion of the units in early 1953 will enable the engineering college to undertake new defense research," according to Dr. S. C. Hollister, dean of the college.

The sponsoring committee has Walker L. Cisler '22, of Detroit, executive vice president of the Detroit Edison Co., as chairman. Its goal is $736,000 to add to gifts of $1,000,000 made to the Engineering Development Fund over the past several years by alumni, other individuals and business, and industrial concerns.

Results reported to date leave a
(Continued on page 44)



College News

(Continued from page 42)

balance of $561,000 to be obtained through the efforts of the committee.

Construction of the engineering units began in March. They will be named for Dr. Robert H. Thurston, first president of the American Society of Mechanical Engineers, who was Director of Mechanical Engineering at Cornell from 1885 until his death in 1903, and Dexter S. Kimball, professor emeritus, who was the first Dean of the University's College of Engineering.

Thurston Hall will have facilities for work in problems of stresses and the testing of engineering materials and structures. Kimball Hall will contain machine shops and equipment for teaching and research in tool design, plant layout and organization, production techniques and time-and-motion studies.

Hollister On Cover

A photograph of Dean S. C. Hollister of the College of Engineering at Cornell was the cover picture for the August 9 issue of Engineering News Record magazine.

Dean Hollister, the newly elected president of the American Society for Engineering Education, is described as "prime mover in the drive to assure an adequate supply of trained civil engineers to man the nation's defense effort and keep its civilian plant in prime condition."

Cottrell Elected

Prof. C. L. Cottrell of the School of Electrical Engineering at Cornell has been elected chairman of the Central New York Section of the Illuminating Engineering Society. He will be installed October 5.

At the same meeting, the group will officially mark its change in status from "chapter" to "section" of the national organization. The new charter will be presented by Prof. E. M. Strong of the School of Electrical Engineering, vice president of IES.

Both Professor Cottrell and Professor Strong will attend the annual technical conference of the IES in Washington, D. C., during the week of August 27.

Professor Cottrell specializes in problems of vision and illumination. His paper on "Measurement of Visibility," presented at the IES meeting in Pasadena last August, appeared in the February issue of Illuminating Engineering.

Hydraulics Paper

A technical paper on hydraulics by Prof. Melville S. Priest of the School of Civil Engineering at Cornell has been published by the Engineering Institute of Canada.

The paper, "Air Entrainment by Water in Steep Open Channels," is the third in the Institute's series of technical studies in engineering.

"The design of high-velocity channels has hitherto been based largely on experience and rule-of-thumb," according to the Institute. Professor Priest, it said, presents a theoretical solution which should "be of interest to all engineers who design spillways and other hydraulic structures where high velocities may occur."

HERBERT J. RASS

ENGINEER—in charge of OPPORTUNITIES

by HERBERT J. RASS, *Manager, Employment Department*
ALLIS-CHALMERS MANUFACTURING COMPANY (*Graduate Training Course 1942*)

MAYBE that's a far-fetched way of putting it—but I am an engineer (Marquette 1941, Electrical Engineering) and a great many men do pass through the Employment Department to opportunities with Allis-Chalmers. I did the same thing myself.

During my last two years at Marquette in Milwaukee I worked as a cooperative student at Allis-Chalmers on the electrical test floor, in electrical product departments on both design and application work, and in the shops. When I graduated, I continued in the Graduate Training Course, on training location with what is now the Employe Relations Department. After six months—opportunity came around to look me up. The Company officer in charge of Industrial Relations talked to me about personnel work and asked if I'd like to go on with it as a career.

Liked Working With People

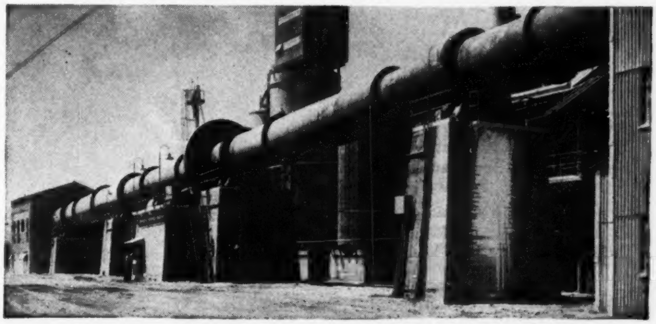
By that time I'd seen a lot of the Company, both product design and manufacturing, and I knew I liked working with people better than with machines, so it was just the break I wanted. During the war I was in the shops on personnel work, got a thorough grounding on operations carried on throughout the plant, and made many contacts. In 1950 I was made manager of the Employment Office.

Recruiting engineers for the Graduate Training Course is one of our functions, and perhaps this is a good place to tell something about the course.

The course here is actually tailor-made for each man, and you help plan it. You can work it out to get concentrated training and experience in almost any phase of work that you want . . . even go on and get advanced degrees. Or, like so many of us, you may use it as an opportunity to get experience with many phases of the Company's operations.

Industry's Broadest Range

There are over 75 training locations for Graduate Training Course engineers at Allis-Chalmers' Milwaukee Plant alone. They include research, design and sales application on a wide range of products such as motors and generators, crushing, cement and mining machinery, steam and hydraulic turbines, centrifugal pumps, transformers, electronic equipment and milling machinery.



This is a 7 ft. x 8 ft. x 250 ft. rotary lime sludge kiln. Allis-Chalmers is also an important supplier of kilns to the cement industry.

Giant spiral casing for hydro power project is one way of showing that Allis-Chalmers can build them big.

That's only part of it. You can go into the shops and manufacturing end of the business—work in planning and production control, personnel, time study, wage determination and labor relations. Or, there's laboratory and research, purchasing, advertising, sales training, export sales. Somewhere during the two-year course you're going to get a start in the work that suits you best. If you have the stuff, opportunity is going to come your way.

If you'd like more information about the Graduate Training Course, stop in for a visit at your nearest Allis-Chalmers district or regional office—or write for literature.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin

STRESS and STRAIN...

ODE TO MY SLIDE RULE

Women are always babbling
Of dates and drinks and dresses,
Which doesn't help at all when I'm
Computing strains and stresses.
My slide rule conquers everything
From calc to sines to surds,
And helps me do my work without
An avalanche of words.

To hell with women's wanton ways,
With eyebrows, lips and curls.
My little log-log-polyphase
Is worth a dozen girls.

(Obviously this fellow is unacquainted with the finer things of life.)

* * *

"Why did you have one side of your car painted red and the other blue?"

"It's a swell idea. You ought to hear the witnesses contradict one another."

* * *

Her hand torched mine—sensation.
Her hair was close—contemplation.
Her lips brushed mine—temptation.
Footsteps in the hall—DAMNATION!

* * *

The young man knew his girl could keep a secret because they had been engaged three weeks before he knew anything about it.

* * *

Flattery is 90% soap.
Soap is 90% lye.

* * *

Thermo Prof: "Who's smoking in the back of the room?"

ME: "No one—that's just the fog we're in."

Wife (to her drunk husband): "Let's go to bed."

Hubby: "Might as well . . . I'll catch hell when I get home anyway."

* * *

Coed: "Don't you love driving on a night like this?"

ChemE (or any E.): "Yes, but I thought I'd wait till we got farther out in the country."

* * *

He isn't stiff
Who from the floor,
Can lift his head
And bellow, "MORE."

* * *

House dick on phone: "Are you entertaining a man up there?"

Dora: "Just a minute and I'll ask him."

* * *

Breathes there a Chem.E. with soul so dead
Who never to himself hath said,
(While he is entering Baker Lab):
"Phee-ew!"

* * *

Fortune teller: "You will be unhappy until you're forty."

Gretchen: "And then?"

Fortune Teller: "You'll get used to it."

* * *

There was once a freshman (in Arts) who thought a logarithm was a lumberman's song.

* * *

Love is one game never called on account of darkness.

Sven got into the mine elevator, chuckling out loud.

"What's the joke, Sven?" asked the mine foreman.

"Ay ban have a good joke on Ole," he replied. "Ay just find out that Ole pay my wife five dollars to kiss her and I do it for nothing."

* * *

An ancient professor in an art gallery was gazing intently at a portrait of a shapely girl, clad in a few strategically placed leaves. The title of the portrait was "Spring." Suddenly the voice of his wife snapped, "Well, what are you waiting for, Autumn?"

* * *

She: "My dad is an engineer. He takes things apart to see why they won't go."

He: "So what?"

She: "You better go."

* * *

Beggar: "Got a nickle for a cup of coffee, bud?"

ChemE: "Oh, I'll manage somehow, thanks."

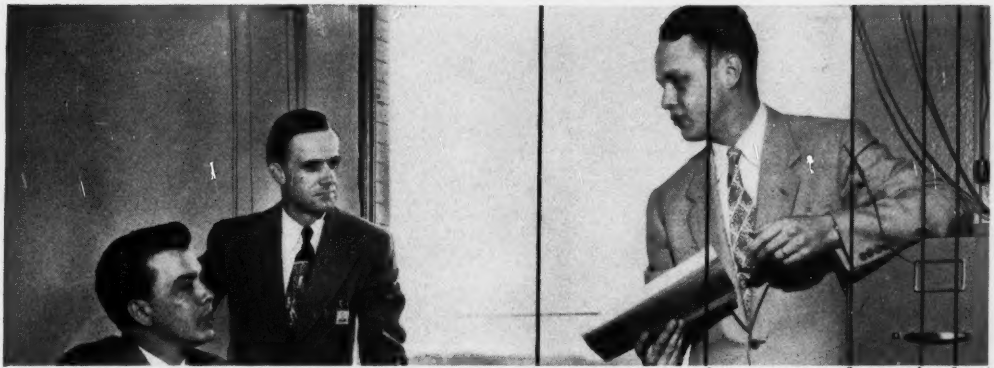
* * *

October Brain Teasers:

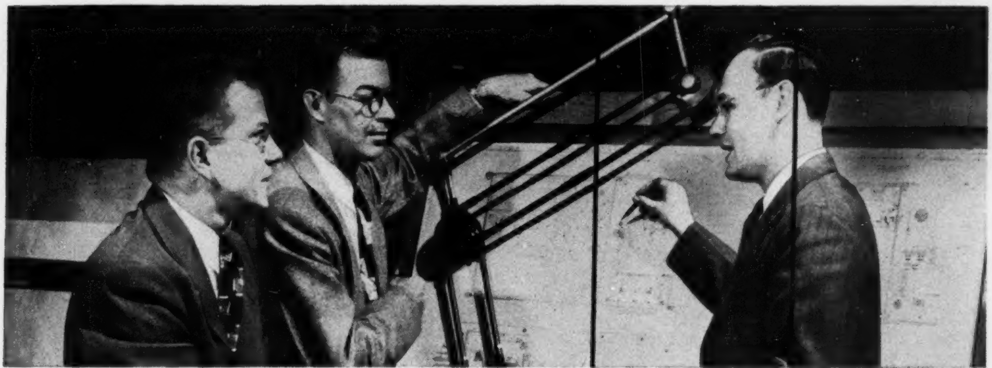
(1) How may a twelve foot square rug be cut in two and only two pieces so that when sewn together again, a nine by sixteen foot rug is formed?

(2) Assume that you have a set of dominoes, each dominoe being one inch by two inches, and that you also have a chess board, in which each square measures one inch square. If the two corner squares diagonally opposite on the board are left uncovered, can you then arrange the dominoes so that the remainder of the board is entirely covered? If not, why not?

Answers next month.



Accounting, Auditing, 55% | Marketing, 17% | Admin., 15% | Other Jobs, 7% | Advt., 3% | Mfg., 3%



Research—Development, Design, Production, Application Engineering, 60% | Marketing, Sales, 20% | Other Jobs, 20%

What happens to all the college graduates General Electric hires?

About 55 per cent of the graduates of General Electric's Business Training Course are now making their careers in accounting and auditing work. About 17 per cent are in marketing; 15 per cent in administrative and management; 3 per cent in advertising; 3 per cent in manufacturing; with 7 per cent in fields ranging from purchasing to employee relations.

Of the more than ten thousand engineers and other specialists at General Electric, about 60 per cent are in some phase of engineering or research, with 20 per cent in marketing, and the other 20 per cent in manufacturing, purchasing, etc.

Figures like these help to prove that there are no fixed paths for college graduates at General Electric. The graduate who enters a G-E training program doesn't commit himself irrevocably to one type of work.

It's a G-E tradition to encourage the newcomer to look around, try several different assignments on for size, find the kind of job which he believes will be most satisfying and to which he can make the greatest contribution.

You can put your confidence in—

GENERAL ELECTRIC